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# FIFTIETH ANNUAL REPORT

OF THE

Mass:

COMMISSIONERS

ON inland

# FISHERIES AND GAME

FOR THE YEAR 1915.

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# COMMISSIONERS ON FISHERIES AND GAME.

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CLAM REPORT.

# The Commonwealth of Massachusetts.

*To His Excellency the Governor and the Honorable Council.*

The Commissioners on Fisheries and Game respectfully submit their fiftieth annual report.

## General Considerations.

At this time it is particularly appropriate to call attention to the extensive development in methods of conserving fish and game which has taken place in the half century which has elapsed since the founding of this commission in 1866. Especially in recent years numerous laws, public education in respect to fish and game conservation, oversight of the commercial fisheries, and extensive propagation of birds, quadrupeds and fish have expanded many fold the once simple routine of this department.

Constantly changing conditions affecting both fish and game have contributed largely to the increasing complexity and correspondingly greater necessity for the work. However, the commission in its plans for the proper utilization of the great natural facilities with which Massachusetts is favored has expanded to meet and even anticipate the demands of the present era. By the establishment and administration of a definite system of law enforcement, by the increase of birds and animals in our coverts and fish in our waters, and by the education of the public, this department is endeavoring to fulfill its great mission of conserving our natural fish and game resources. In this way your commissioners have contributed largely to the benefit of all sections of the Commonwealth. No State department is more worthy of receiving public support and encouragement than the Commission on Fisheries and Game in its endeavor to restore to the present generation and its descendants at least part, or even more, of the abundance of fish and game which our ancestors enjoyed.

Your commissioners must administer their work to the end that maximum efficiency may be reached at a minimum cost, a point which can be attained only by a definite system for all branches so co-ordinated and so specific that it may meet the increasing demands which are constantly being made. The work of every subsidiary department is growing rapidly, and only carefully worked-out plans, based on accurate methods of policy and thorough knowledge of the public needs, can enable this commission to maintain its present high standing among other States. The details of our recent activities and suggestions for future development are presented in the following pages.

*Recommendations.*

The Commissioners on Fisheries and Game respectfully recommend the passage of laws designed to accomplish the following purposes: —

1. To provide for the punishment of persons assaulting or interfering with officers enforcing the fish and game laws.

2. To provide for the control of certain great ponds by the commissioners for the purpose of cultivating useful fish, birds and quadrupeds.

3. To amend chapter 118, Acts of 1911, by increasing the penalty for the violation of the provisions of said chapter relative to the taking of hares and rabbits.

4. To provide a penalty for the violation of chapter 542, Acts of 1913, relative to hunting with rifles and revolvers.

5. To amend section 133, chapter 91, Revised Laws, relative to the discharge of waste materials into public waters.

6. To amend chapter 270, Acts of 1913, relative to gray squirrels.

7. To amend section 8, chapter 92, Revised Laws, as amended by Acts of 1903, chapter 330, relative to the use of the bodies or feathers of certain birds for millinery purposes.

8. To amend section 67, chapter 91, Revised Laws, as amended by chapter 329, Acts of 1904, relative to pickerel.

9. To amend chapter 118, Acts of 1907, relative to loons and grebes.

10. To amend chapter 465, Acts of 1912, relative to appointment of town wardens.

11. To authorize the Commissioners on Fisheries and Game to take or receive as a gift, or lease or purchase in the name of the Commonwealth, such improved or unimproved property as they may deem necessary, and to control and use such property.

12. Relative to hunting of game on State reservations, parks, commons or land held in trust for public use, or upon public highways.

13. To amend chapter 472, Acts of 1910, extending protection to the Bartramian sandpiper, upland plover, heath hen, wood duck, wild or passenger pigeon, Carolina or mourning dove, gulls or terns.

*Organization.*

Under the supervision of the three commissioners the work of the commission comprises four main divisions, viz., (1) central office organization, (2) law enforcement, (3) fish and game propagation, and (4) scientific investigation.

The central office, under the immediate direction of the commissioners, serves a twofold purpose: (1) as bureau of information for the general public and the Legislature, and (2) as the central clearing house for the entire department. The commissioners, in addition to devoting considerable time at the central office, make many trips to different parts of the Commonwealth for the purpose of keeping in close touch with the various phases of the work and the needs of the different localities. The office force comprises a chief clerk, a bookkeeper, three stenographers and an office boy. A vast amount of miscellaneous information relating to fish and game is dispensed by personal interviews and by detailed correspondence in reply to numerous queries from all sections of the State. All matters relating to hunters' licenses, statistics of shore fisheries, production and development of hatcheries, reports of deputies, and weekly statements of the various departments are efficiently handled at this office.

The enforcement of the fish and game laws is restricted to the services of a corps of deputies, under the immediate supervision of a chief deputy, who directs the work from the central office by constantly keeping in touch with the various districts. Under the existing system each deputy has to cover

approximately 415 square miles of territory, necessitating continuous vigilance and arduous work. Massachusetts can justly be proud of the excellent manner in which her fish and game laws are enforced by the efficient and conscientious men now holding these positions. In addition to the regular deputies there are a number of town wardens and unpaid deputies, many of whom are of great assistance in the proper enforcement of law. Efficiency in law enforcement is not indicated merely by the number of convictions secured, but rather by the more important preservation of fish and game through the prevention of law infractions.

The propagation of fish and game is carried on at four fish hatcheries, situated at Palmer, Adams, Sutton and Sandwich, and at six game farms, at Wilbraham, Sutton, Norfolk, Sharon, Marshfield and East Sandwich, each in charge of a superintendent who is directly responsible to the commissioners. By means of a system of weekly reports and by frequent inspections the commissioners keep constantly in touch with the progress of the work at these hatcheries and game farms, in this way exerting direct control over the propagation of fish and game.

The biologist and his assistant have oversight of all scientific investigations and from time to time make reports on the results of various studies upon fish and game. A number of routine biological, pathological and bacteriological examinations are made upon material sent to the office from various sections of the State, and the services of this division are always available to any resident of the Commonwealth.

## *Finances.*

The expenditures and receipts for the year 1915 are itemized in the following tables. The appropriations for the past year totaled $150,195.53, of which $138,181.49 was expended, leaving a balance of $12,014.04.

| | |
|---|---|
| Expenditures, | $138,181 49 |
| Receipts, | 64,538 60 |
| Gross cost, | $73,642 89 |
| Value of fish and game output from hatcheries, | 58,338 18 |
| Net cost, | $15,304 71 |

*Disbursements for 1915.*

| | |
|---|---|
| Commissioners' salaries, | $6,040 00 |
| Clerical, | 5,268 07 |
| Expenses, | 6,228 24 |
| Enforcement of laws, including expenses and salaries of deputies, | 47,337 64 |
| Maintenance of fish hatcheries, propagation of food and game fish, purchase of egg lobsters, establishment of bird and game preserves, maintenance of game farms, and propagation of wild birds and quadrupeds, | 66,026 04 |
| Stocking great ponds with food fish, | 497 36 |
| Establishment of fish hatcheries, | 2,777 66 |
| Establishment of fish hatchery especia'ly adapted for shad (chapter 115, Resolves of 1915), | 81 00 |
| Increasing supply of food and game fish (chapter 159, Resolves of 1914), | 897 03 |
| Land for hatcheries (chapter 135, Resolves of 1915), | 1,000 00 |
| Publication of laws (chapter 89, Resolves of 1915), | 1,507 37 |
| In favor of Pittsfield Angler's Club (chapter 44, Resolves of 1915), | 259 00 |
| Investigation of fisheries of Buzzards Bay (chapter 19, Resolves of 1915), | 262 08 |
| Total, | $138,181 49 |

*Receipts for 1915.*

| | | |
|---|---|---|
| Licenses: — | | |
| Nonresident at $10, | $1,365 85 | |
| Nonresident at $1, | 142 15 | |
| Resident at $1, | 60,368 05 | |
| Alien at $15, | 1,358 25 | |
| | | $63,234 30 |
| Game tags, | $356 85 | |
| Sale of Buzzards Bay fish, | 322 70 | |
| Interest on deposits, | 3 77 | |
| Sale of produce at Wilbraham, | 279 59 | |
| Sale of produce at Sutton, | 243 23 | |
| Sale of produce at Sharon, | 38 37 | |
| Sale of produce at Vineyard Reservation, | 25 28 | |
| Sale of produce, and fee for fighting fires at East Sandwich Game Farm, | 31 66 | |
| Sale of carp from Laurel Lake (per cent. only), | 81 | |
| Sale of rubber and 1 gallon of oil, Sandwich, | 2 04 | |
| | | 1,304 30 |
| Total for fiscal year 1915, | | $64,538 60 |

No fees have been received for the inspection of fish in accordance with the provisions of chapter 138, Acts of 1912.

## *Educational Efforts.*

An increasingly important activity is the education of the public in all matters relating to the conservation of our fish and game. Undoubtedly publicity is a most essential factor in the preservation of our natural resources, and is especially necessary for the proper enforcement of laws, which are primarily for the protection of fish and game for the benefit of the public. Not only the foreign-born citizen, but the majority of our complacent, easy-going native population, need such education to enable them to realize the urgency and value of this type of work. Until the public is keenly alive to the importance of and knows the reason for fish and game conservation, no great advance can ever be made, since the enactment and proper enforcement of laws for their protection and propagation depend upon public opinion, as reflected by the members of the General Court. For these reasons it is highly desirable that in the future greater efforts be directed by this commission toward the education of the public along the lines here outlined.

*Publications.* — Each year the work of this department as a bureau of information, not alone for Massachusetts but for other States as well, is increasing. Public interest constantly demands that this information be placed in convenient form for distribution. Nevertheless, the results of our scientific investigations lie for months, even years, unpublished, owing to lack of proper appropriations to cover the cost of printing. One report of limited distribution is printed annually, which contains a variety of subjects, but necessarily cannot include important special reports. For this reason it is not only highly desirable but essential that a radical change be made in publication methods, by the inauguration of a system of special popular bulletins, each of which would chiefly deal with a single subject, and which would be of suitable form for convenient and cheap distribution.

*Boy Scouts.* — In Europe, where the public has been taught to respect wild life, the children take genuine interest in the preservation and propagation of birds, and private citizens engage extensively in the artificial cultivation of fish and game

under conditions which until lately have been considered impracticable in this country. In interesting the boys and girls in outdoor life and recreation the promotors of the Boy Scouts' and Camp Fire Girls' organizations are doing an excellent work. Yet what a valuable opportunity for useful work is neglected by not utilizing such organizations for the protection of our wild birds and animals! If these boys and girls, soon to become the men and women of our land, were given a proper knowledge of fish and game, and taught how to be of service collectively and individually, a great and important step would be accomplished. In addition to broadening their own education, the Boy Scouts could be of active service to this commission by (1) patrolling water and land areas during closed seasons, (2) locating forest fires, (3) feeding birds in winter, (4) recording the abundance of fish and game in their sections of the State, and (5) reporting violations of the laws. Plans are now under way to develop this important asset, and to institute closer association between the commission and such organizations as the Boy Scouts.

The following suggestions as to the means of interesting the Boy Scouts in fish and game conservation are given: —

1. Frequent lectures and informal talks upon fish and game work before the various patrols.

2. Co-operation of scout masters and district deputies in patrolling woods and streams at special times.

3. Furnishing grain and other bird food for winter distribution.

4. Providing opportunities for the scouts to visit fish hatcheries and game farms, with accompanying demonstrations of practical methods in fish and game propagation and distribution.

5. Granting suitable prizes or some form of recognition for proficiency in fish and game work.

6. Arranging for definite statistical surveys of the wild life in woods and streams.

*Exhibitions.* — The policy of giving practical information to the public by means of exhibiting live birds, fish and other products has been in vogue for several years. These exhibitions, which have been made at agricultural fairs, poultry

shows, food fairs and various society entertainments in all parts of the Commonwealth, have aroused great interest and should be further extended.

The commission is continually receiving requests from schools and societies for permanent demonstration exhibits of fish and birds. These are supplied to the best of our ability, and it is hoped that sufficient funds will soon be forthcoming to enable this department to furnish more and better educational displays.

*Lectures.* — Frequently illustrated lectures are given by the commissioners before societies, churches, granges and sportsmen's associations, in which the various phases of fish and game conservation and propagation are described. This work is meeting with hearty response and encouragement on all sides, and should prove an important educational feature worthy of further expansion.

*State Associations.* — The policy of encouraging and aiding the formation of gunning and fishing associations has already begun to yield important results. The number and size of these associations is steadily increasing, and their influence is beginning to have a strong bearing upon fish and game legislation and protection. The aim of this commission has been to co-operate with these associations in the enforcement of laws and in the distribution of fish and game, thus receiving additional assistance in constructive work.

*National Activities.* — The educational work of your commissioners has not been confined merely to home affairs, but they have endeavored to maintain the high standing of Massachusetts among other States. They have been consulted upon national problems relating to fish and game, and have been active officials in organizations such as the National Association of Shellfish Commissioners, the American Fisheries Society, the National Conservation Congress and the National Association of Game and Fish Wardens. By visits to other States in their official capacities, your commissioners have established a broader viewpoint, and have acquired new ideas for the development of the resources of our Commonwealth.

*Commercial Fisheries.* — It is highly desirable that the scope of our educational efforts in the marine fisheries may be ex-

tended to meet the great advances now being made in the commercial fisheries. Already the lobster fishermen have formed associations for their own protection and for the preservation of the lobster. The efforts of the members of these associations in co-operation with this department argue well for the future of this industry.

The achievements of the New England Fish Exchange, the Boston Fish Bureau and the Boston Wholesale Fresh and Salt Fish Dealers Association, resulting in the new fish pier and the introduction of more sanitary methods of handling fresh fish, together with those of the salt-fish industries of Gloucester, show the influence of education. The importance of teaching conservation in the marine fisheries cannot be overestimated, and the need of proper facilities for furthering this work is sadly apparent. With the important fishing port of Boston as a center, a fisherman's institute, similar to that now operating in Japan, might readily be established, where a definite course of training could be offered to men desirous of entering the fishing industries. In addition, lectures and demonstrations could be given in the various shore towns, and associations organized for discussion and study of the current problems. Publications upon various commercial subjects, with lessons on their practical application, could be regularly distributed. The need for this type of work is great, and the response should be overwhelming. The accomplishment of such results can be achieved by State appropriations, and the whole-hearted co-operation of all those interested in our commercial fisheries.

## Enforcement of Law.

One of the most important activities of the commission is the enforcement of the laws relating to fish and game, which each year become more numerous and complicated. In previous reports we have strongly urged their simplification, and have even presented a complete codification, which, however, has met with no co-operative response from the Legislature. As a result our deputies are burdened with an excessive amount of work which would be unnecessary under more simple and explicit laws. The law enforcement is administered by a chief deputy, twenty-eight district deputies and a variable number

of special deputies; in addition, town and unpaid wardens assist in the work. In our regular deputies we have a corps of energetic, upright men, influential in their respective communities and capable of conducting the work quietly but with great efficiency. They are under civil service, have dedicated their lives to the work and are striving constantly to increase their usefulness.

The report of Chief Deputy Orrin C. Bourne upon the enforcement of the law during the past year follows: —

Dr. George W. Field, *Chairman, Commissioners on Fisheries and Game, State House, Boston, Mass.*

Sir: — I herewith submit my report for 1915 upon the enforcement of the fish and game laws.

*Deputies.* — During the year 1915 the force consisted of 28 district deputies, 10 special deputies and about 30 town wardens. The work of all these men is worthy of the highest commendation. The position of a deputy is no sinecure. His duties do not end at any stated hour of the day, but he must be on duty day and night, alert to all that may transpire in his district of 415 square miles. Saturdays, Sundays and holidays are his busiest days. The open season each year brings into the fields and woods a vast army of hunters and fishermen. In many districts large areas can be covered only on foot, and it may require a several days' tramp for one deputy to cover the entire length of certain streams. Many hunters and fishermen own automobiles and thus are able to cover the country at such a rate that if they once locate a deputy whom they desire to avoid they can easily shift the scene of action to a distant locality.

The so-called alien law has presented new problems to our deputies, since many aliens do their hunting with small caliber rifles which can be heard but a short distance and can easily be concealed in their clothing. The number of laws is increasing every year, many of which are of such a nature that it would take the entire time of two men to properly enforce them in a single district. Since chapter 240, General Acts of 1915, prohibiting certain aliens from owning, using or having rifles and shotguns in possession, went into effect, about 50 cases of aliens hunting have been placed before the courts, and about 40 shotguns and rifles (nearly all cheap makes) have been confiscated. Fifty-dollar fines have been imposed and paid in several cases. A few have shown to the satisfaction of the court that a fine would be a great hardship to their families, and on agreement to do no more hunting the cases have been filed.

*Forest Fires.* — A number of forest fires were reported by our deputies. In several instances small fires were discovered and quickly extinguished, thus saving valuable property.

*Transportation.* — Our deputies still have to employ the same methods of travel as of yore, either riding in trains or hiring a team at a cost of $2 or $3 a day. If an automobile is used the cost is prohibitive, since it entails the additional cost of employing a chauffeur, with the result that our deputies are still practically confined to the slowest means of locomotion, while the violators have the most up-to-date means of covering the country. Along the water front high-power boats are used by the fishermen and duck hunters, yet the deputies must be content with such makeshift boats as they may hire on short notice. Practically it is impossible to rent a boat suitable for our work, as the owners say that they do not care to risk injury to boats and other property through retaliative acts of violators.

*Fish and Game Distribution.* — The amount of fish available for stocking our brooks and ponds has rapidly increased within the last few years, and their distribution requires the expenditure of additional time by our deputies, who necessarily must be in touch with all water courses to know what fish are suitable and what places are posted against public fishing, in order that State fish may not be put into private waters. The special knowledge necessary in handling the fry, fingerlings, yearlings and adult trout, and the delicate fry of the pike perch, yellow perch and bass, can be acquired only by long and careful study.

The distribution of pheasants, ducks, quail and white hares has also to be attended to by the deputies, while the feeding of quail, pheasants and other birds during the severe winter weather necessitates considerable work.

*Pollution.* — The enforcement of the law relative to the taking of clams in polluted areas, which was delegated to this department by the State Board of Health, is by no means an inconsiderable problem, since the courts called on to handle this matter do not impose sufficiently heavy penalties to force the clammers to give up their illicit practices.

*Convictions.* — A comparison of the number of court cases and the amount of fines turned into the Commonwealth for the past few years will show an increase from year to year. In 1915 a total of 610 arrests were made, of which 559 were by regular district deputies, 18 by special deputies, 17 by unpaid deputies, 2 by town wardens and 14 by police officers.

Our deputies have been selected because of their recognized ability to meet the varying conditions under which they have to work. It is necessary that a deputy should, in addition to being well versed in wood-lore, hunting and fishing, with particular knowledge of the covers, ponds and streams in his district, be able to recognize violations of the law, to know the proper methods of apprehending and handling violators before they are brought into court, and to be thoroughly acquainted with legal procedure in regard to making out complaints and stating cases clearly in court, even when arrayed against the best legal talent.

*Office Work.* — The work of the chief deputy in connection with law enforcement has been confined largely to the central office, with occasional

visits to the various district deputies. To illustrate the inadvisability of devoting his entire time to field supervision of the district deputies it may be stated that if but one day were devoted to visiting each deputy it would take thirty days to cover the whole State, and at that it would necessitate traveling from district to district at night, which would mean but twelve visits to each man in a year. Better results can be obtained by directing the operations of the deputies from the central office. Many people call at the office for special information relative to the interpretation of fish and game laws, and necessarily they require the services of the chief deputy or some one in authority. There are many calls by deputies for assistance when two men or more are required, necessitating an order from the office for the requisite assistants. The forty or more narrative reports from paid deputies, town wardens and superintendents of hatcheries are read each week by the chief deputy, who thus is enabled to keep in close touch with each district. Annual reports from about 300 people connected with the department must be read to get a reasonable idea of the increase of birds, fish and animals in various localities. During the warmer months much time has to be devoted to the distribution of fish, mainly in transferring shipments through Boston to their proper destinations, as occasionally, for unforeseen reasons, the district deputy engaged in this work may be called for some urgent court case, and thus may be unable to receive the consignment.

During the winter the chief deputy follows the fish and game affairs before legislative hearings, locates the various bills and sees that the commissioners are posted as to their progress. He has charge of distributing the fish and game law books, cards, extracts and other literature, and has general oversight of the reports of deer and pheasants killed in the open and closed seasons.

Respectfully submitted,

ORRIN C. BOURNE,
*Chief Deputy.*

## 1915.

| Violation. | Number of Cases. | Discharged. | Convicted. | Appealed. | Filed. | Fines imposed. | Fines paid. | Costs of Court. |
|---|---|---|---|---|---|---|---|---|
| Sunday hunting, . . | 63 | 1 | 62 | 8 | 8 | $1,172 00 | $437 00 | $20 00 |
| Hunting without license, . | 108 | 10 | 98 | 1 | 20 | 865 00 | 757 00 | 1 96 |
| Possession of short lobsters, | 24 | - | 24 | 1 | 1 | 444 75 | 200 75 | - |
| Illegal possession of short pickerel. | 19 | - | 19 | - | - | 77 00 | 56 00 | - |
| Possession of pickerel in closed season. | 4 | - | 4 | - | - | 30 00 | 30 00 | - |
| Illegal possession or hunting of game. | 22 | 5 | 17 | 3 | 2 | 170 00 | 120 00 | 2 60 |
| Taking herring before they cast spawn. | 1 | - | 1 | - | - | 3 00 | - | - |
| Placing poison to kill animals. | 1 | - | 1 | - | - | 50 00 | 50 00 | - |
| Using scented bait without owner's permission. | 2 | - | 2 | - | 2 | - | - | - |
| Hunting, wounding or killing deer. | 7 | - | 7 | - | 2 | 125 00 | 100 00 | - |
| Illegal killing of deer during open season. | 7 | 2 | 5 | - | - | 105 00 | 105 00 | - |
| Killing or possession of song or insectivorous birds. | 17 | 1 | 16 | - | 5 | 180 00 | 120 00 | - |
| Setting snares, . . . | 3 | - | 3 | - | - | 30 00 | 25 00 | - |
| Hunting, after being convicted within one year. | 1 | - | 1 | 1 | - | 10 00 | - | - |
| Assault on officer in performance of duty. | 2 | - | 2 | - | - | 25 00 | 10 00 | - |
| Fishing in closed ponds, . | 4 | - | 4 | - | 4 | - | - | - |
| Carrying concealed weapon, | 3 | - | 3 | 2 | - | 160 00 | 10 00 | - |
| Possession of short trout, . | 12 | - | 12 | - | - | 106 00 | 106 00 | 2 00 |
| Illegal possession of black bass. | 14 | - | 14 | - | 1 | 64 00 | 44 00 | - |
| Using sweep net in Buzzards Bay. | 2 | - | 2 | - | - | 20 00 | 20 00 | - |
| Illegal taking of fresh-water fish. | 9 | - | 9 | 2 | - | 85 00 | 45 00 | - |
| Killing eagle, . . . | 1 | - | 1 | - | - | 10 00 | 10 00 | - |
| Setting fish trap without permit. | 1 | - | 1 | 1 | - | - | - | - |
| Setting nets illegally in ponds. | 4 | - | 4 | - | - | 80 00 | 40 00 | - |
| Taking short quahaugs, . | 2 | - | 2 | - | - | 10 00 | 10 00 | - |
| Setting fish trap in closed season. | 2 | - | 2 | 2 | - | 200 00 | - | - |
| Violation of shellfish laws, | 78 | 6 | 72 | 14 | 28 | 1,060 00 | 65 00 | 42 00 |
| Hunting with ferret, . | 19 | - | 19 | - | 1 | 135 00 | 135 00 | - |
| Hunting with rifle during open season on deer. | 5 | - | 5 | - | 1 | 85 00 | 75 00 | - |
| Possession of seed lobsters taken from Massachusetts waters. | 1 | - | 1 | - | 1 | - | - | - |
| Illegally killing rabbits, . | 8 | - | 8 | - | 4 | 14 00 | 14 00 | - |
| Hunting on posted land, . | 31 | - | 26[1] | 7 | 7 | 160 00 | 47 00 | - |
| Taking alewives contrary to rules of selectmen of Bourne. | 2 | - | 2 | - | 2 | - | - | 7 00 |

[1] Five pleaded *nolo contendere.*

**1915.**

| Violation. | Number of Cases. | Discharged. | Convicted. | Appealed. | Filed. | Fines imposed. | Fines paid. | Costs of Court. |
|---|---|---|---|---|---|---|---|---|
| Illegal possession of or taking smelt. | 9 | - | 9 | - | - | $215 00 | $95 00 | - |
| Illegal possession of white perch. | 3 | - | 3 | - | - | 6 00 | 6 00 | $1 80 |
| Possession of or killing heron or bittern. | 2 | - | 2 | - | 2 | - | - | - |
| Failure to make return of money as required by law. | 1 | - | 1 | - | - | 75 00 | - | - |
| Molesting and interfering with lobster traps. | 8 | 5 | 3 | - | - | 30 00 | 30 00 | - |
| Taking oysters illegally, . | 1 | - | 1 | - | - | 10 00 | 10 00 | - |
| Exceeding bag limit on quail and partridge. | 3 | - | 3 | - | - | 45 00 | 45 00 | - |
| Illegal taking of fish in Lynn Harbor. | 21 | - | 21 | 3 | 8 | 535 00 | 430 00 | - |
| Securing license through misrepresentation as to naturalization. | 5 | - | 5 | - | 1 | 70 00 | 45 00 | - |
| Fishing with more than ten hooks. | 2 | - | 2 | - | 1 | 20 00 | 20 00 | - |
| Violations of the alien gun law. | 53 | 3 | 50 | 3 | 12 | 1,800 00 | 950 00 | 30 00 |
| Illegal taking of fish in Salem waters. | 12 | - | 12 | 12 | - | 600 00 | - | 10 00 |
| Setting fires, . . . | 2 | 2 | - | - | - | - | - | - |
| Breaking and entering camp. | 1 | - | 1 | - | - | - | - | - |
| Killing pheasant in private enclosure. | 1 | - | 1 | - | - | 10 00 | - | - |
| Interfering with officer in performance of duty. | 1 | - | 1 | 1 | - | 25 00 | - | - |
| Hunting on State reservation. | 14 | - | 14 | 3 | 4 | 85 00 | 65 00 | 7 10 |
| | 618 | 35 | 578 | 64 | 117 | $9,001 75 | $4,327 75 | $124 46 |

## Inland Fisheries.

The importance of developing our inland fisheries is annually becoming more significant. The policy of your commissioners will follow two general lines, (1) the stocking of public waters and (2) the encouragement of private fish propagation. The first is the direct work of this commission, the second an indirect result of the first.

Several factors govern the wholesale stocking of public waters. (1) These waters must be kept free from pollution and other causes which may impair their fish-producing powers. (2) This commission must have an accurate and thorough knowledge of the physical characteristics of the waters themselves, a groundwork which has already been laid by a preliminary survey of all the streams and ponds in the Common-

wealth. (3) The waters to be stocked must be judiciously selected and the fish for stocking carefully chosen in order that the right species may be placed in waters suited for their growth and existence. This can be accomplished only with a thorough knowledge of the waters and the life history and habits of the various species of fish, such as this commission by the course outlined above is steadily acquiring. (4) There should be a definite and uniform program for stocking certain bodies of water for several years, with a follow-up system. (5) An increase both in the number and species of fish propagated is necessary to adequately increase the yield of our waters for the benefit of the recreationist and sportsman, as well as to provide an abundant food supply for the public.

This commission, as previously stated, has collected data on all waters in the State, and in many instances has decided upon the species of fish best suited for stocking purposes. It has outlined a definite plan for systematic stocking, and is now engaged in developing and increasing the production of fish at the hatcheries in order to carry out the proposed program.

In addition, experiments in fish propagation are now being tried, notably the introduction of the Chinook salmon of the Pacific coast into our large inland lakes. Incidentally, efforts are to be made to establish this fish in the Atlantic Ocean by placing them in a tributary of the Merrimac River. The proposed establishing of a shad hatchery on a tributary of the Taunton River should revive interest in this excellent fish, which is now all but gone from our coast; also, plans are now under way for the re-establishment of the alewife fisheries in many coastal streams. Only through experimental work of this nature can appreciable advance in fish propagation be achieved.

*Fishways.*

The early colonists soon utilized the coastal and later the inland streams for water power by building dams, thereby causing barriers to the passage of migratory fish. Numerous laws were passed prohibiting the erection of dams without suitable fishways on coastal streams where alewives abounded, but the same care was not taken in the case of the inland streams. Nevertheless, the coastal streams have fared but

little better than the inland streams, since these laws were either evaded or directly disobeyed, with the result that, owing to their nonenforcement, but few and at best inefficient fishways were ever installed.

The primitive successful type, known as the Cape Cod fishway, consisted of a trench or sluiceway dug around the dam, in which the current was checked by large stones laid at short intervals. This fishway answered very well for alewives but had the objection of wasting water, and proved impossible to construct in certain localities. To enlarge this type to a size sufficient for the passage of shad and salmon would have caused serious injury to many mill privileges. In the smaller Massachusetts streams the Brackett fishway has proved the most practicable from the standpoint of efficiency and cheapness.

In determining upon the installation of fishways your commissioners base their decisions upon the potential value of the stream for fishing. During the past year the dilapidated condition of fishways in many alewife streams has received attention, and efforts have been made, particularly at Middleborough, Harwich and other places, to see that proper fishways were installed which would allow the passage of the alewives to their spawning grounds. The general policy has been to require the erection and proper care of fishways wherever the welfare of the fisheries demanded it.

The question of fishways in the Merrimac River is now under consideration by this commission. Attempts are soon to be made to rear Chinook salmon at North Andover, and when these and other migratory fish give any promise of an appreciable increase, definite steps will be taken for the installation of the best types of fishways at Lawrence and Lowell. Efforts are also being made to stock the upper waters of this river with food and game fish, and action will be taken in the matter of screening the entrance of canals and flumes, since the existing law does not compel the owners to screen these outlets and inlets. By erecting suitable fishways on these dams, by eliminating unnecessary and harmful pollution, and by systematically stocking the headwaters of the Merrimac it is hoped that appreciable results may be obtained in restoring these once important fisheries.

*Pollution.*

Chapter 460, Acts of 1910, forbade the discharge into the streams of the Commonwealth of sewage, manufacturing waste or any material which directly or indirectly would prove prejudicial to fish life, either by injuring the fish themselves or by destroying the food of the young fish, such as microscopic plants or animals. It has been found that even slight chemical pollution of water causes the gills to become inflamed, thus rendering the body more susceptible to disease, while larger quantities of polluting material may actually kill fish.

Important decisions have been made by the courts, which are of great value not alone to the citizens of Massachusetts but to the citizens of the entire United States. One case went to the Supreme Court on the contention that the defendants had been putting this polluting material into the streams for upwards of two hundred years; and upon this ground they claimed that they had gained by prescription the right to continue the pollution. The Supreme Court specified particularly in their decision that an individual or corporation could not acquire such a right against the State by prescription, and that the fact that they had not earlier been prevented from putting this material into the streams was no reason why they could not be so prevented at any time. (Commonwealth *v.* Holyoke Water Power Company.)

Likewise, in judging what constituted the "fisheries value" of a stream, the commissioners have been directed to consider not alone the present value of the fish in that stream, but its potential value for the production of food fish, as well as its recreational value to the general public.

Hereafter the law will be enforced from this standpoint. We do not contemplate rabid agitation or ill-advised attempts to force manufacturers to act prejudicial to their real interests, but we expect in the course of five or ten years to take some progressive steps toward the purification of the inland waters. In this connection we must consider not alone the actual destruction of fish life, but the corresponding waste of a vast amount of valuable material which should be used for fertilizing land.

Section 8, chapter 91, Revised Laws, as amended by chapter 356, Acts of 1906, prohibits the discharge of sawdust into fishing streams. Recent experiments by the National Bureau of Fisheries have demonstrated that sawdust promotes the growth of fungus on fish eggs, thus killing both eggs and young fish. Sawdust affects the larger fish by clogging their gills, or by the liberation of chemical substances inducing an inflammatory condition of these organs. The elimination of this source of pollution is highly desirable.

Future work upon the pollution of streams will consist in the recording of all cases, the elimination of unnecessary sources of pollution upon good fishing streams, particularly when the remedy may be applied at small expense, and a biological investigation of the effect of different types of pollution upon fish life. Fish propagation will prove a bountiful success only when suitable waters are prepared to receive the small fish and support the immense numbers they should normally produce.

*Pond Culture.*

In addition to more than 800 State ponds with an area of 20 acres or more, Massachusetts possesses a wealth of private ponds which are either natural bodies of water of less than 10 acres, or artificial. The inherent resources of the United States are immeasurably greater than those of other countries, but in spite of the natural abundance of unrivaled streams, springs and small bodies of water of every character scattered profusely over the entire country, little advantage has been derived in the commercial production of fish. It is high time that the people of Massachusetts were awakened to a realization of the benefits accruing from proper development of inland waters.

An acre of water suitably adapted to fish propagation is worth more to the farmer, dollar for dollar, than a corresponding area of upland. Previous to this time the American farmer has devoted but casual attention to the utilization of aquatic resources, which has resulted in the present useless condition of small streams and undrained swamp land. Massachusetts waters are abundantly supplied with hardy fishes well adapted for this work. No serious difficulties are presented in obtaining them for breeding, and under cultivation

they should yield a food supply supplementary to that derived from public fisheries to a degree that is by no means negligible. Fish-rearing conditions have been thoroughly investigated and satisfactorily worked out at both State and national fish hatcheries, and information thus obtained is always available for the benefit of the private fish culturist. In Massachusetts there are several private fish hatcheries which conduct a profitable business in trout rearing, and there is no question but that many other species might be included through modification of present methods, making possible a wholesale utilization of our ponds and streams. At present Massachusetts might be termed a mere trailer in this undertaking when compared with some of the countries of Europe, where cultivation of fish has been supported by private interests for centuries. Not only is this true of large estates, but even small landowners keep hundreds of acres of ponds in a state of active production. Stations and schools for experimentation are supported to teach farmers economic methods of raising carp and other fish. Doubtlessly this condition is a logical result following exhaustion of fish supply in public waters, a condition not so remote as to preclude its becoming a real possibility in Massachusetts unless greater regard is given to suggestions of this commission in the development of public waters.

In proportion to labor and time invested returns from fish propagation are great, since after the initial expense and work but little labor is necessary until the adult fish are marketed. Pond culture is certainly to be recommended as a means of lowering the high cost of living by utilization of a present but undeveloped asset. Actual figures compiled with regard to a pond in Kansas by Prof. Lewis L. Dyche of the State commission evidence a remarkable yield from a small body of water. In three years the yield from 16,000 fish placed in a small shallow pond was practically 27,000 fish, weighing a total of 6,809 pounds. During this experimental period 1,400 pounds of food were fed to the fish. The temperature of the water ranged from 70 to 91 degrees F. during the month of August, which is considerably warmer than the temperature of Massachusetts waters, and may explain this unusually enormous yield. Although this tremendous increase cited may not be

obtained in our waters, it may be approximated, and is a fact worthy of attention as indicating the seemingly limitless extent to which artificial fish propagation has been made a reality.

Ponds of Massachusetts may be classified as natural (those which are usually spring fed and formed by small streams or in the hollow of some natural depression) and artificial, which class may be subdivided, according to the method of construction, into ponds formed by dams, those excavated and those produced by embankments or dikes. Small artificial ponds, especially those excavated, are easily and successfully made from swamp land. Ponds formed by dams are less suited for pisciculture since they are more exposed to spring floods and freshets, and, similarly, embankment ponds are of less advantage than those excavated.

Water supply of a pond is dependent largely upon the natural conditions existent, therefore streams are first choice, though closely followed by artesian wells which have a steady flow. One point in favor of the latter is that they furnish water of more uniform temperature, and if free from chemicals detrimental to aquatic life they are perhaps the most satisfactory providers. Hard water is very naturally undesirable for fish rearing. Undoubtedly damming of streams to form ponds is the more common means to be adopted, owing to the fact that springs are not readily found in sufficient numbers to furnish the required water, but by the use of pumps and wells, natural depressions in many cases may be formed into ponds suitable for fish raising.

The size and shape of a pond is a matter contingent to prevailing natural conditions. According to Prof. George C. Enbody the most satisfactory size to provide sufficiently for a small family would be between one-half and one acre, and the shape would have very little bearing upon the production. Depth has considerable to do with the temperature of the water and mitigation of the severity of the effects of winter weather. Possibly an average depth of not over 3 feet would be satisfactory if the pond had a "kettle basin" in one part, as is often the case at the State hatcheries, from which the fish are readily removed when a pond is drained. If there

were a depth of 6 feet at this point it would be ample to protect the fish from very thick ice during a severe winter, otherwise a maximum depth of 6 feet for the entire pond would be necessary. As a rule, the more shallow the pond the greater the amount of aquatic vegetation, and, correspondingly, the greater the amount of food; therefore more rapid growth of fish is the logical consequence.

An inlet should be so arranged as to properly regulate influx of water at the discretion of the owner, and the outlet should be so situated as to allow the pond to be completely drained whenever desired. In this manner a convenient way is guaranteed not only for clearing the pond but also for catching fish to be marketed. Suitable provision should be made for keeping a clear outlet, and flashboards should be arranged to regulate the flow. The cost of building such a pond varies with conditions, in many cases depending upon the amount of excavation necessary, but after initial expense the cost of maintenance is slight.

Desirable fish for stocking ponds of such a character are the members of the bass family, sunfish, yellow and white perch, bullheads, pike and pickerel. The pond itself should afford suitable spawning ground, abundant forage and shelter to which the young fish may flee to escape natural enemies. Aquatic vegetation suitable for providing food and shelter should be planted, and fish of minor importance introduced to serve as food for the more desirable species. Late April or early May is perhaps the most advantageous time for stocking a pond.

The procedure in stocking is admirably epitomized by Prof. George C. Enbody, who states as follows in his most excellent paper upon "The Fish Pond," Cornell Agricultural Experiment Station Bulletin: —

(1) Aquatic plants are the first organisms to be planted in the pond. They should be started as early in the spring as possible. (2) Various smaller food animals, such as the crustacea and mollusca, should follow the introduction of the plants immediately. (3) The first year, during the fore part of June, the forage fishes, gold fish and golden shiners should be added, to the number of one hundred pairs of each. (4) Advanced fry of the edible fishes may be planted when available during the first summer; fingerlings in September and October, but yearlings or larger should not be planted until the second summer. (5) The suggested edible

fish for an acre of water are about twenty-five pairs of adult black bass, or fifty pairs of any other kind, from two to three thousand fingerlings or from four to six thousand advanced fry.

A pond should be adequately protected against depredations of noxious animals, the accumulation of rubbish and sediment of various kinds, clogging of screens, and at all times there should be a good volume of water flowing through it. At the expiration of three years fish so propagated should be ready for market.

### *Fish Propagation.*

The recent work at the various hatcheries has progressed rapidly and has resulted in a marked increase in production. Extensive improvements have been instituted in accordance with a definite scheme of development which should result in an increasing annual output. The first of the following tables shows the increase in the value of the 1915 production as compared with the years 1913 and 1914, estimates being made according to the market value of the output of fish. The second table presents a detailed summary of hatching operations and fish production for 1915.

*Summarized Value of Outputs of Hatcheries, 1913, 1914, 1915.*

| | 1913. | 1914. | 1915. |
|---|---|---|---|
| Adams hatchery, | $1,682 50 | $1,475 00 | $1,605 00 |
| Sandwich fish hatchery, | 14,451 75 | 11,925 00 | 16,903 70 |
| Palmer hatchery, | 9,937 00 | 9,992 50 | 20,386 30 |
| Sutton hatchery, | 5,287 50 | 5,178 50 | 5,825 00 |
| Total, | $31,358 75 | $28,571 00 | $44,720 00 |

*Hatchery Operations for 1915.*

| | Eggs. | | Distributed. | | | |
|---|---|---|---|---|---|---|
| | Produced. | Hatched. | Eggs. | Fry. | Fingerlings. | Adult Fish. |
| Brook trout: | | | | | | |
| Sandwich hatchery, | 5,812,000 | 1,405,000 | – | – | 773,000 | 11,525 |
| Palmer hatchery, | – | 1,000,000 | – | 390,000 | – | – |
| Sutton hatchery, | 325,000 | 1,550,000 | – | 1,120,000 | 128,000 | 600 |
| Adams hatchery, | – | 550,000 | – | 450,000 | 40,000 | – |
| Total, | 6,137,000 | 4,505,000 | – | 1,960,000 | 941,000 | 12,125 |
| Brown trout: | | | | | | |
| Sutton hatchery, | 160,000 | 125,000 | – | 105,000 | 2,000 | 290 |
| Rainbow trout: | | | | | | |
| Palmer hatchery, | – | 142,000 | – | – | 52,660 | – |
| Adams hatchery, | – | – | – | – | 500 | – |
| Total, | – | 142,000 | – | – | 53,160 | – |
| Chinook salmon: | | | | | | |
| Palmer hatchery, | – | 50,500 | – | – | 48,500 | – |
| Adams hatchery, | – | – | – | – | 1,100 | – |
| Total, | – | 50,500 | – | – | 49,600 | – |
| Small-mouthed black bass: | | | | | | |
| Palmer hatchery, | – | – | – | 208,000 | 72,320 | – |
| Large-mouthed black bass: | | | | | | |
| Palmer hatchery, | – | – | – | 144,000 | – | – |
| Horned pouts (bullheads): | | | | | | |
| Palmer hatchery, | – | – | – | – | – | 20,300 |

*Hatchery Operations for 1915* — Concluded.

| | Eggs. | | Distributed. | | | |
|---|---|---|---|---|---|---|
| | Produced. | Hatched. | Eggs. | Fry. | Fingerlings. | Adult Fish. |
| Pike perch: | | | | | | |
| Palmer hatchery, | - | - | - | 8,850,000 | - | - |
| Yellow perch: | | | | | | |
| Palmer hatchery, | - | - | - | 10,500,000 | - | - |
| Landlocked smelt, | - | - | 1,000,000 | - | - | - |
| White perch, | - | - | - | - | - | 100,000 |
| Grand total, | 6,297,000 | 4,822,500 | 1,000,000 | 21,767,000 | 1,118,080 | 132,715 |

*Hatcheries.*

*Adams Hatchery.* — The principal improvement at the Berkshire station was the installation by Superintendent Sheldon of 15 pools for rearing fingerlings. These pools were provided with an ample supply of both spring and stream water at a temperature of from 42 to 62 degrees F., which was piped from land above the hatchery. The capacity of the hatchery building was increased and it was wired for electricity.

*Palmer Hatchery.* — The new hatching building has almost doubled the hatching capacity and has proved a most practical aid in handling large quantities of fish. A new ice house has been erected, with an inside cooler for keeping fish food and a grinding room fitted with a one horse power electric motor. Electricity and steam heat have been supplied to both house and hatchery.

Construction work has progressed rapidly under the direction of Superintendent Monroe. Forty-eight rearing pools with screens and covers, 30 bass beds and 30 bass fry retainers have been built. Three batteries of hatching jars capable of holding 50,000,000 pike perch or 30,000,000 yellow perch eggs have been installed at the new hatchery. A new 6-inch iron pipe has been laid from the large reservoir to the rearing pools and one of the two new bass ponds has been completed.

*Sandwich Hatchery.* — Superintendent Hitchings reports that the fiscal year ending Nov. 30, 1915, was successful owing to the excellent condition of the brood stock and the high yield of trout eggs. The deeper cement ponds built in 1914 were an important improvement, as they kept the water cooler and of a more uniform temperature than the former shallow wooden ponds, thus making it possible to carry a larger number of fish in each pool. Seven hundred and eleven visitors, representing 26 States and 2 foreign countries, registered during the year.

The road from the main thoroughfare to the meat house at Sandwich was repaired and a new road made from the meat house to the hatchery. Six new cement ponds were built to replace the old board ones. Electricity was installed in the meat house and in the hatch house, the latter having been completely overhauled and repaired.

At East Sandwich two parcels of land containing 1.34 acres were purchased and a small office was constructed. Six new cement ponds and 3 filter boxes, 2 of cement and 1 of wood, with a 10-inch pipe, were installed.

*Sutton Hatchery.* — Chief among the general improvements at this station was the change in the water supply for the upper hatchery, made by ditching the springs. Seventy feet of 12-inch pipe were laid in the brook to the hatchery and settling tanks of concrete were installed to remove the fine sediment. A double line of concrete pools was built on the site of the old plank pools below the dam, and the south bank of the pond was graded to improve the shore line, thus increasing the space for loading fish.

## *History of Fish Culture in Massachusetts.*

In the year 1725 a worthy individual, Ludwig Jacoby by name, conceived the happy idea of artificial fertilization of fish eggs, and sixteen years later devised a successful method, but it was not until 1761 that his discovery was announced. However, in spite of this early revelation negligible progress was made in this industry up to the year 1850, about seven years after the readoption by Remy of artificial fish propagation. At this time the French started pisciculture on a large scale, with characteristic ardor, and developed the artificial spawning bed, hatching trough, methods of feeding and modes of transporting both eggs and young. At this time their research also included studies on the vitality of fish spermatozoa, the swelling of eggs in water, and the temperature best suited for hatching.

Although Ohio was the first State in our Union to undertake fish culture, as early as 1853, but little was accomplished until 1856, when Massachusetts soon followed by a legislative act appointing commissioners to report "respecting the artificial propagation of fish." They concluded their report with a description of Capt. N. E. Atwood's attempt to hatch trout, and a translation of Jules Haime's article on fish culture, printed two years before that date in the "Revue des Deux Mondes." Valuable as it was, the commissioners' report made little impression, and it was not until the end of the civil war that the subject was again taken up.

In 1865 the States of New Hampshire and Vermont complained that shad and salmon, which had once been abundant within their borders, had been cut off by impassable dams at Holyoke on the Connecticut River and at Lawrence on the Merrimac River. These dams at that time had been in existence for about sixteen years, and the problem of restoring the fish to the upper waters was indeed a difficult one. The commissioners, Theodore Lyman and Alfred A. Reed, appointed by the Legislature to investigate the complaint concluded their report upon the decline and partial destruction of the fisheries of these rivers as follows:—

In order successfully to restock the two rivers with shad and salmon, it would be necessary that fishways should be built over the dams; that the pollution of the water be prevented; that New Hampshire should breed salmon; that Connecticut should forbid the use of weirs and gill nets; and that stringent laws regulating fishing should be passed by the States concerned. . . . If the above conditions were complied with, an abundant supply of fish might reasonably be looked for within five years, though they would not be as plentiful as when the country was in its pristine state.

The Legislature, satisfied that an attempt should be made to re-establish these fisheries, ordered the appointment of permanent commissioners whose duty it would be to cause fishways to be erected at these and other dams. A mill company at Holyoke claimed exemption from any such outlay of money, and had recourse to a court of law, but eventually lost the case after extensive litigation, which resulted in a trial before the Supreme Court of the United States. On the Merrimac the dam at Lawrence presented in itself quite as great a physical obstacle as the legal impediment at Holyoke, and several years of experimentation were expended before a fishway of the least practical value was erected.

In 1867 the Legislature in this connection passed two important acts, one of which prohibited the catching of shad, salmon and alewives in the Merrimac for four years; forbade fishing within four hundred yards of any fishway thereon; empowered the commissioners to see that fishways were maintained on this stream and its tributaries, and directed cities

and towns along the banks of the river to appoint fish wardens. The other enlarged and broadened the scope of the powers of the commissioners by allowing them to open all possible streams to the passage of fish, and appropriated $10,000 to be used in restocking rivers and ponds with valuable species. Thus, from being originally charged with certain executory powers upon two rivers, the commissioners were given unreserved authority to open all streams, and undertake comparatively extensive piscicultural experiments.

In the autumn of the year 1868, the commissioners established a small hatching house at Maple Spring in Wareham, a move made possible by the invaluable assistance of Mr. S. T. Tisdale, who donated sufficient land and contributed to the building fund. Up to the time of his death this public-spirited gentleman continued to interest himself in this undertaking. During the two seasons which it operated over 30,000 fishes were hatched, the majority of which were salmon, trout, land-locked salmon and lake trout.

During the early years after the establishment of the commission in 1866, shad and salmon were extensively hatched, and less attention was devoted to brook trout. Shad and salmon hatching mark the early period of fish propagation, and with the disappearance of these fish from the rivers hatching operations naturally ceased. Trout culture succeeded salmon and shad propagation, although first considered as only adapted for private hatcheries. Necessity and popular demand induced the State to propagate this fish, and led to the inauguration of the Sutton hatchery when the joint hatchery at Plymouth, N. H., was discontinued. Since then the output of trout has greatly increased, and in recent years other fish, such as yellow, white and pike perch, the Chinook salmon and black bass, have been propagated.

In 1880, 500 carp were, unfortunately, introduced, and distributed in forty different localities. They were placed indiscriminately by private and public means into waters such as Laurel Lake, Lee, and Spy Pond, Arlington, where they have ruined the once excellent native fishing. Although good small pond fish, this species never should have been placed in ponds connected with large public waters.

The process of fertilization and hatching fish, although comparatively simple, requires care and watchfulness. The ripe females are taken from the ponds in large nets, and the operator, carefully handling each fish, removes the ripe spawn by stripping, which is caught in a tin pan or other suitable receptacle. Having once secured the eggs the next step is fertilization. This embraces the taking of milt from the males in a manner similar to that in which eggs are obtained from the females, and thoroughly mixing it with the eggs by a gentle stirring with a feather. After this procedure the eggs are washed several times in cold water before being spread on hatching trays. During incubation constant care is required to keep the water fresh and moderately cool. Cold water prolongs the period of incubation and warm water correspondingly lessens it, thus making possible regulation of the time at which the young are hatched, a fact which, under certain conditions, is of great value. During incubation it is necessary that close watch be maintained in order that dead eggs may be removed by means of bulb pipettes or tweezers. Such eggs are readily detected because of their characteristic white color. Certain species of fish, on account of anatomical peculiarities, cannot be successfully propagated artificially by the method of stripping, and require different methods of rearing. A good example of this class is the black bass, which is reared in ponds from eggs deposited in gravel nests, and the young as soon as hatched protected by fine wire netting placed over the spawning beds.

The history of fish propagation in Massachusetts is so intimately associated with three hatcheries now abandoned, the joint hatchery at Plymouth, N. H., the Winchester hatchery and the Hadley hatchery, that a brief review of their operations gives an excellent idea of the status of fish propagation in the past as compared with the more efficient methods now in vogue, and demonstrates the great advance Massachusetts has made in the last four years.

| Hatcheries. | Year opened. | Year closed. |
| --- | --- | --- |
| Winchester hatchery, | 1870 | 1911 |
| Joint Plymouth hatchery, | 1878 | 1895 |
| Sutton hatchery, | 1891 | - |
| Hadley hatchery, | 1896 | 1906 |
| Adams hatchery, | 1898 | - |
| Sandwich hatchery, | 1911 | - |
| Palmer hatchery, | 1912 | - |

*Winchester Hatchery.* — In 1870 the hatchery was established by Edward A. Brackett, who was for nearly thirty-nine years a member and for twenty-seven chairman of this commission. For twenty years the use of the entire place, with equipment, was given without charge to the State. In 1895 the need of rebuilding was found to be imperative, and a new stone hatchery was equipped at a cost of $3,000, under chapter 74, Resolves of 1897, on land belonging to the Metropolitan Park Commission at the entrance to Middlesex Fells.

Salmon were hatched until 1877, when the greater part of operations were transferred to the joint hatchery at Plymouth, N. H., but the landlocked and California varieties were still reared. From 1879 to 1894 trout fry were raised from the eggs procured at the joint hatchery at Plymouth, N. H. It still continued in operation in spite of a gradually failing water supply, until it was formally abandoned and turned over to the Metropolitan Park Commission in 1911.

*Joint Hatchery.* — Massachusetts and New Hampshire jointly established a trout and salmon hatchery at Plymouth, N. H., in 1877, at a cost of less than $4,000. The hatchery house and ponds, supplied with both spring and river water, were located at Livermore Falls, within a stone's throw of the river, where the spawning salmon were taken in weirs. In 1882, 33 Merrimac salmon were taken in the fall run, and 125,000 eggs obtained, but the greater portion of those hatched came from the Penobscot River.

Beginning with the year 1879 trout eggs were taken, half the yield being shipped to the Winchester hatchery, and four

years later a large trout pond was fitted up for the accommodation of brood trout. In 1889, 100,000 salmon eggs were taken from salmon in the Merrimac. At this time the hatchery, which was destroyed by fire, was rebuilt, and a new building 25 by 26 feet, with an office and work room at one end, was erected. New hatching troughs and trays were put in, and a new meat house 10 by 14 feet was located near the breeding ponds. In 1893 extensive repairs were made on the hatchery grounds and new tanks were installed for the brood trout.

In 1893 a legislative committee from New Hampshire made an investigation of the joint relations of the two States, but no report was made. In 1894 the New Hampshire Legislature passed a resolve, and soon after a similar one was passed by Massachusetts, looking to a separation of the joint interests of the two States, with the result that the hatchery was abandoned, and the Massachusetts interests transferred to the Sutton hatchery.

*Hadley Hatchery.* — Three thousand dollars was appropriated under chapter 114, Resolves of 1896, for a hatchery in the western part of the Commonwealth. The site chosen at East Hadley comprised over 7 acres of land, including a spring-fed pond of 1 acre, with a fall of 10 feet to the stream below the dam, two springs of pure clear water, and the control of 12 feet on each side of the stream for a distance of 1,000 feet below the pond. The hatchery building, 41 by 28 feet, was built of brick, comprising a main room 25 by 39 feet and two rooms 8 by 11 feet on the second floor. An inch and a half pipe 300 feet long connected the building with the middle spring, giving a good supply of water with a fall of 30 feet. In 1899 the upper dam was strengthened, another sluiceway installed, and two ponds built.

In 1900 the question of securing an adequate water supply of a temperature suitable for raising fingerlings became a serious problem, which was partially solved by the lease of an additional brook, with option of purchase, and by driving artesian wells. However, eventually results were disastrous, as the brook water proved to be too warm for rearing the small fish, and rendered the production of fingerlings impossible.

In 1905 the town of Hadley, by the erection of water works and by the diversion of the water at Harts Brook, ruined the hatchery, and in 1906, after the matter had been placed in the hands of the Attorney-General, the hatchery was practically abandoned, although a few fry were hatched as late as 1910.

| Year. | Joint Hatchery, Plymouth, N. H. | | Winchester Hatchery. | | | |
|---|---|---|---|---|---|---|
| | | | | Salmon Fry. | | |
| | Penobscot and Merrimac Salmon Fry. | Trout Eggs. | Trout Fry. | Penobscot. | Land-locked. | Californian. |
| 1870, . . . | – | – | – | 2,200 | – | – |
| 1871, . . . | – | – | – | – | – | – |
| 1872, . . . | – | – | – | 21,000 | – | – |
| 1873, . . . | – | – | – | 185,000 | – | 27,000 |
| 1874, . . . | – | – | – | 271,000 | 5,500 | 27,000 |
| 1875, . . . | – | – | – | 250,000 | 10,000 | 75,000 |
| 1876, . . . | – | – | – | – | – | – |
| 1877, . . . | – | – | – | – | 150,000 | 72,000 |
| 1878, . . . | – | – | – | – | 245,000 | 89,000 |
| 1879, . . . | – | – | 45,000 | – | 224,763 | – |
| 1880, . . . | – | – | 37,500 | – | 176,000 | – |
| 1881, . . . | 411,000 | – | 80,000 | 47,000 | 288,000 | – |
| 1882, . . . | 454,983 | – | 47,000 | – | 108,000 | – |
| 1883, . . . | 392,000 | – | 65,500 | – | 185,000 | – |
| 1884, . . . | 540,000 | – | 115,000 | – | 196,000 | – |
| 1885, . . . | 330,000 | – | 120,000 | – | 218,400 | – |
| 1886, . . . | 600,000 | 500,000 | 245,000 | – | 100,000 | – |
| 1887, . . . | 495,000 | 775,000 | 380,000 | – | 50,000 | – |
| 1888, . . . | 195,000 | 1,000,000 | 375,000 | – | 115,000 | – |
| 1889, . . . | 590,000 | 750,000 | 340,000 | – | – | – |
| 1890, . . . | 230,000 | 1,000,000 | 450,000 | – | – | – |
| 1891, . . . | 200,000 | 1,000,000 | 410,000 | – | – | – |
| 1892, . . . | 190,000 | 1,000,000 | 520,000 | – | – | – |
| 1893, . . . | – | 846,000 | 320,000 | – | – | – |
| 1894, . . . | – | 800,000 | 350,000 | – | – | – |

*Shad.*

In view of the proposed attempt now under consideration to restock the Taunton River through the establishment of a shad hatchery, it may be well to review what has previously been accomplished in Massachusetts along this line. There is no fish which is more deserving of every possible effort for propagation than the shad, and there is abundant hope that with our present knowledge the establishment of a shad hatchery on the Taunton River may prove a great boon to our river fisheries.

*Connecticut River.* — In 1867 the commissioners secured the services of Seth Green, who began experiments in the hatching of shad at Holyoke on the Connecticut River. He first tried unsuccessfully to hatch the eggs in a trough supplied with brook water, as in trout hatching, but later he replaced the bottom and ends of a wooden box with wire gauze, and after putting in a layer of eggs floated it in the river. Sixty hours later the water inside was found to be alive with little transparent embryos, about one-third of an inch long, resembling mosquito larvæ. The discovery was made, and it remained only to perfect this improved hatching box by attaching to its sides wooden bars at an angle with the bottom, so that the box floated with one end elevated. The passing river current caused a boiling motion of the water within, which kept the eggs from collecting in heaps. Following this plan shad hatching was conducted by the Connecticut Commission, and later by the United States Commission, at South Hadley Falls on the Connecticut River, until about 1886.

The average production of the fisheries for the years 1864 to 1869 was only two-fifths of that for the years 1827 to 1836, and each year had shown a successive decline. In 1870 there was a large run of shad, which continued for several years, and the season of 1875 was the best in twenty years. The result in 1870 and later has reasonably been attributed to the artificial hatching by Green in 1867, although restrictive laws upon netting were passed in Connecticut at the same period. In 1878 the declining fishery involved Massachusetts and Connecticut in a dispute, provoked for the most part by the

lack of restrictive legislation on the part of the latter State. The number of eggs obtained diminished considerably, and in 1880, owing to the exorbitant price demanded for rental of seining grounds, hatching operations were discontinued.

*Merrimac River.* — From the building of the Lawrence dam to the closing of the Merrimac River by an act of the Legislature in 1866, the shad had gradually decreased, until all the seining grounds below the dam, except three, had been abandoned as worthless. In 1868 shad fry were planted in Lake Winnepesaukee, the Concord River and the Mystic River. In the autumn of the same year shoals of young shad and alewives were seen above Lowell passing seaward.

In 1868 Mr. A. C. Hardy, as agent for the Massachusetts commissioners, began hatching shad at North Andover on the Merrimac. With an intermission of six years between 1876 and 1882 hatching operations continued without interruption until 1891, when the Lawrence and Lowell dams, supplemented by unrestricted seining in the lower Merrimac, caused its abandonment, owing to a dearth of spawning fish. The following shows the results of the first period of hatching in regard to the number of spawning shad taken: —

| | | |
|---|---|---|
| 1869, . . | 1,554 shad | No other fishing allowed on the river. Average for two years, 1,154. |
| 1870, . . | 754 shad | |
| 1871, . . | 2,242 shad | No other fishing allowed on the river. Average for three years, 1,942. |
| 1872, . . | 2,031 shad | |
| 1873, . . | 1,555 shad | |
| 1874, . . | 1,692 shad | Other fishing again allowed on river. Average for two years, 1,562. |
| 1875, . . | 1,433 shad | |

The first two years represent the natural catch at that time. In 1871 Hardy's hatch of 1868 should have returned as marketable fish, and, in fact, the next three years show an average nearly double the two preceding. In 1874 the river was again thrown open to fishermen, and the average for 1874 and 1875 came between the first two and the second three years. These results would seem to indicate a decided increase in fish by reason of artificial hatching, but the point was never satisfactorily proved, since for six years all fishing in the Merrimac except at Andover was prohibited. In 1888 an attempt to hatch shad on the Taunton River proved unsuccessful.

*Salmon.*

The transplanting of Chinook salmon to Massachusetts waters is being rapidly carried on. The eggs are received in large consignments from the Pacific coast, and the young fish hatched at our stations are reared to the fingerling size, 4 to 6 inches, before planting. Certain ponds in the State which possess the necessary natural qualifications suitable for this fish are being thoroughly stocked, and the results are being observed as to the success of landlocking this species, particularly with regard to the question of reproduction. So far we have stocked: —

Lake Quinsigamond, Worcester.
Stockbridge Bowl, Lee.
Onota Lake, Pittsfield.
Cliff Pond, Brewster.
Long Pond, Wellfleet.
Lake Garfield, Monterey.
Big Alum Pond, Sturbridge.
Long Pond, Plymouth.

In addition to stocking the deep fresh-water lakes an attempt will soon be made to liberate a number of these fish in the Merrimac River, with the intention of ascertaining whether the once famous salmon fisheries may not be restored. In view of this attempt it is well to consider that which has previously been accomplished with the salmon in Massachusetts.

In 1870, 1,000 fry were raised at the joint hatchery on the Merrimac River, and 700 on the Mystic River. At Maple Spring, a hatchery of Mr. Samuel Tisdale, from 1868 to 1870, 3,325 Atlantic salmon and 4,575 landlocked salmon were reared. The first lot of 2,557 landlocked salmon reared at the Winchester hatchery was distributed in 1870. In 1871 salmon spawn was procured from Charles G. Atkins at the Penobscot River, where the fish were retained in a small pond until the eggs were ripe, at a considerably lower cost than the Canadian salmon eggs could be obtained. In 1872, 21,000 were hatched and distributed from eggs obtained at the Penobscot River, Me., in conjunction with the Maine Commission.

From 1873 to 1878 California salmon fry, presumably the Chinook, were hatched and liberated in Massachusetts waters, and during a period of three years no Penobscot or Merrimac salmon fry were liberated in the Merrimac River. In 1878

it was decided not to introduce any more California salmon until more was known about their life history, especially since no adult fish of those introduced into Massachusetts streams had ever been taken.

Between 1874 and 1889 landlocked salmon were reared at the Winchester hatchery from eggs obtained in Connecticut, and distributed in various lakes and ponds throughout the Commonwealth.

At the joint hatchery at Plymouth, N. H., operated by New Hampshire and Massachusetts, eggs were taken from Merrimac salmon until 1893, but the greater portion came from the Penobscot River, Me. With the closing of the joint hatchery extensive rearing of salmon practically ceased.

| Year. | Shad. | | | | Salmon Fry. | | |
|---|---|---|---|---|---|---|---|
| | Merrimac River. | | Connecticut River. | | | | |
| | Number of Fish. | Eggs taken. | Number of Fish. | Eggs taken. | Penobscot and Merrimac. | Landlocked. | Californian. |
| 1867, | - | - | - | - | - | - | - |
| 1868, | - | - | 7,341 | - | - | - | - |
| 1869, | 1,672 | - | 8,807 | - | - | - | - |
| 1870, | 799 | 1,950,000 | 11,618 | 60,000,000 | 2,200 | 7,132 | - |
| 1871, | 4,336 | 4,530,000 | 10,634 | - | - | - | - |
| 1872, | 2,447 | 5,925,000 | 7,691 | 92,065,000[1] | 21,000 | - | - |
| 1873, | 2,691 | 11,595,000 | 7,294 | 44,556,000[1] | 185,000 | - | 27,000 |
| 1874, | 3,016 | 44,556,000 | 15,057 | 800,000[1] | 271,000 | 5,500 | 7,000 |
| 1875, | 1,433 | 6,670,000 | 9,135 | 3,035,000[1] | 250,000 | 10,000 | 75,000 |
| 1876, | - | - | 10,741 | - | - | - | - |
| 1877, | - | - | 2,674 | 3,000,000[1] | - | 150,000 | 180,000 |
| 1878, | - | - | - | - | - | 245,000 | 425,000 |
| 1879, | - | - | - | - | 190,000 | 224,763 | - |
| 1880, | - | - | - | - | 95,000 | 176,000 | - |
| 1881, | - | - | - | - | 446,000 | 288,000 | - |
| 1882, | 654 | 1,227,000 | - | - | 454,983 | 108,000 | - |
| 1883, | 428 | 1,607,000 | - | - | 392,000 | 185,000 | - |
| 1884, | 166 | 252,000 | - | - | 540,000 | 196,000 | - |
| 1885, | 704 | 528,000 | - | - | 330,000 | 218,400 | - |
| 1886, | 644 | 695,000 | - | - | 600,000 | 100,000 | - |
| 1887, | 765 | 1,600,000 | - | - | 495,000 | 50,000 | - |

[1] Fry liberated.

| Year. | Shad. | | | | Salmon Fry. | | |
|---|---|---|---|---|---|---|---|
| | Merrimac River. | | Connecticut River. | | Penobscot and Merrimac. | Land-locked. | Californian. |
| | Number of Fish. | Eggs taken. | Number of Fish. | Eggs taken. | | | |
| 1888, . . . | 291 | 1,145,000 | – | – | 190,000 | 115,000 | – |
| 1889, . . . | 98 | 700,000 | – | – | 590,000 | – | – |
| 1890, . . . | 62 | 190,000 | – | – | 230,000 | – | – |
| 1891, . . . | – | – | – | – | 200,000 | – | – |
| 1892, . . . | – | – | – | – | 190,000 | – | – |

*Brook Trout.*

Trout streams throughout the State have suffered severely during the past year from the extreme weather. Many streams never before known to fail in water were reported as practically dry, and when rain finally came, were then completely flooded. Cold weather and high water prevailed for several weeks during the early part of the trout season, but later the extremely hot weather brought many large trout up the streams, so that fair catches were reported. Many good trout streams, now almost destitute, will require constant care for several years to restore them to their former condition.

*Trout Culture.* — Between 1868 and 1870 at Maple Spring, a tributary of the Agawam River, 20,281 brook trout and 2,450 lake trout were raised by Mr. Samuel Tisdale, and 16,496 were reared at the Winchester hatchery. In 1872, when the private trout hatchery of D. A. Gilbert & Son was established at Plymouth, a total of 3,000 trout were raised in various parts of the State. As the cultivation and rearing of trout came more strictly within the scope of private enterprise, it was decided not advisable for the State then to devote any time or expense in that direction. In 1879 about 100,000 trout eggs were taken from the brood stock at the joint hatchery at Plymouth, N. H. Later half the output, Massachusetts' share, was annually shipped to the Winchester hatchery. After abandoning the Plymouth hatchery the brood fish were kept at the Sutton hatchery, which supplied the Winchester and Adams hatcheries with eggs. In 1911 the Sandwich hatchery took the place of the Sutton hatchery as the principal produc-

ing station, and it now supplies annually 6,000,000 trout eggs. A great advance has been made in the change from fry to fingerling distribution, a system which was first started at the Sutton hatchery. The best results in stocking are obtained by using fingerlings, but naturally their rearing is more expensive. At times rainbow and brown trout have been reared at the hatcheries, but their number has been inconsiderable compared with the brook trout. The following table shows the consistent and rapid development in the production of brook trout in Massachusetts: —

*Brook Trout.*

| Year. | Fry. | Fingerlings. | Yearlings and Adults. |
|---|---|---|---|
| 1879, | 45,000 | - | - |
| 1880, | 37,500 | - | - |
| 1881, | 80,000 | - | - |
| 1882, | 47,000 | - | - |
| 1883, | 65,000 | - | - |
| 1884, | 115,000 | - | - |
| 1885, | 120,000 | - | - |
| 1886, | 245,000 | - | - |
| 1887, | 389,000 | - | - |
| 1888, | 375,000 | - | - |
| 1889, | 340,000 | - | - |
| 1890, | 450,000 | - | - |
| 1891, | 410,000 | - | - |
| 1892, | 520,000 | - | - |
| 1893, | 410,000 | - | - |
| 1894, | 350,000 | - | - |
| 1895, | 375,000 | - | - |
| 1896, | 550,000 | - | - |
| 1897, | 790,000 | - | - |
| 1898, | 900,000 | - | - |
| 1899, | 900,000 | - | - |
| 1900, | 850,000 | - | - |
| 1901, | 865,000 | 44,750 | - |
| 1902, | 1,010,000 | 65,000 | - |
| 1903, | 913,000 | 59,600 | - |
| 1904, | 954,500 | 40,400 | - |

*Brook Trout* — Concluded.

| Year. | Fry. | Fingerlings. | Yearlings and Adults. |
|---|---|---|---|
| 1905, | 969,000 | 45,875 | - |
| 1906, | 815,000 | 38,450 | - |
| 1907, | 855,000 | 58,000 | - |
| 1908, | 773,000 | 112,600 | - |
| 1909, | 802,000 | 128,900 | - |
| 1910, | 720,000 | 123,500 | - |
| 1911, | 591,000 | 132,000 | - |
| 1912, | 1,826,000 | 342,000 | 12,700 |
| 1913, | 2,836,700 | 828,000 | 7,770 |
| 1914, | 2,110,000 | 581,050 | 13,422 |
| 1915, | 1,960,000 | 941,000 | 12,125 |

## Game.

Each year the demand for more extensive stocking of the coverts of the Commonwealth becomes greater, and in attempting to meet this requirement our game farms are being rapidly brought to that state of perfection which will furnish the maximum yield at a minimum expense. The total output of game birds has largely increased; new species, chiefly of the duck family, are being experimented with, and special efforts are being made to rear quail and ruffed grouse in appreciable numbers. In addition to the commendable work accomplished at our six game farms, numerous protective reservations have been established, where the birds are given a sanctuary to feed and breed, free from molestation.

Hand in hand with the great work of propagating these game species goes the protection of our natural supply of birds through law enforcement. Instructions have been given our deputies to record the amount of game in possession of each hunter met in the woods during the open season for the purpose of obtaining an approximate idea of the comparative abundance of game in the various sections of the State, in order that a basis for future comparisons as to the respective increase or decrease in the different species of game may be formed. During 1915, 3,423 hunters were interviewed, 2,433

of whom had no game in their possession and 990 had a varying amount. The relative abundance of the different species are as follows: rabbits, 521; squirrels, 396; ducks, 300; ruffed grouse, 230; quail, 99; pheasants, 96; whistlers, 93; sandpipers, 72; coots, 66; plover, 62; muskrat, 58; deer, 41; woodcock, 22; geese, 16; foxes, 13; robins, 8; skunks, 5; raccoons, 4; snipe, 4; bluejays, 3; pigeons, 1; crows, 1; chewinks, 1; chipmunks, 1; woodchucks, 1; kingfishers, 1.

### *Private Game Farms.*

The policy of the commission has always been to encourage in every possible way the artificial propagation of game birds. Chapter 567, Acts of 1913, provides that a person, firm or corporation may, upon request, receive a permit to propagate any species of deer, elk, pheasants, quail, partridge, geese, wild ducks or squirrels for sale, exchange or to be given away. People are beginning to recognize the benefits accruing from such undertakings, as is well evidenced by the annually increasing number of permits issued. The following table shows the commendable results being obtained, particularly with pheasants and ducks, and it should be borne in mind that all such work contributes toward the public welfare.

If birds raised according to the provisions of this act be sold for food, dead or alive, a second permit is required, and a numbered tag must be attached either just before or immediately after they are killed. To enable the commissioners to approximately estimate present stock an annual report is required from each breeder. Once having received sufficient impetus, a great step will be accomplished by this movement towards the establishment of game propagation in our Commonwealth.

*Summary of 420 Reports by Holders of Breeders' Permits for the Year 1915.*

| Species. | Number of Brood Stock on Hand Dec. 1, 1915. | Hatched during 1915. | Reared during 1915. | Number sold, exchanged or given away during 1915. | | |
|---|---|---|---|---|---|---|
| | | | | For Food. | Propagation. | Eggs sold or given away. |
| Pheasants, | 2,485 | 6,057 | 2,968 | 453 | 1,042 | 2,800 |
| Quail, | 117 | 287 | 202 | 128 | 2 | 112 |
| Ducks, | 3,002 | 5,299 | 2,786 | 880 | 552 | 1,992 |
| Geese, | 1,974 | 696 | 597 | 54 | 213 | 46 |
| Cranes, | 24 | - | 1 | - | - | - |
| Hawks, | 1 | - | - | - | - | - |
| Crows, | 1 | - | - | - | - | - |
| Turkeys, | 10 | - | - | - | - | - |
| Guinea hens, | 10 | 40 | - | 15 | - | - |
| Deer, | 52 | 2 | - | 4 | - | - |
| Ruffed grouse, | 2 | - | - | - | - | - |
| Partridge, | 1 | - | - | - | - | - |
| Squirrels, | 4 | - | - | - | - | - |

Total number of permits, 578.

## *Game Propagation.*

The first table shows the value of the output of the game farms for the years 1913, 1914 and 1915, based on the actual market value of the birds when liberated. The second table gives a condensed report of the operations of the various game farms, including the number of each species distributed.

*Summarized Value of Outputs of Game Farms, 1913, 1914, 1915.*

| | 1913. | 1914. | 1915. |
|---|---|---|---|
| Sutton hatchery, | $5,287 50 | $2,643 50 | $4,162 41 |
| Sharon station, | 1,059 80 | 864 50 | 718 62 |
| Sandwich station, | - | 2,393 25 | 2,317 36 |
| Norfolk State Hospital Reservation, | 539 00 | 687 50 | 510 40 |
| Marshfield Reservation, | - | - | 45 00 |
| Wilbraham game farm, | 2,995 00 | 3,967 75 | 5,864 39 |
| Totals, | $9,881 30 | $10,556 50 | $13,618 18 |

*Game Farm Operations.*

| | Eggs. | | Birds Liberated. | |
|---|---|---|---|---|
| | Hatched. | Distributed. | Young. | Old. |
| Ring-necked pheasants: | | | | |
| Wilbraham, | 4,509 | 2,125 | 962 | 400 |
| Sutton, | 1,541 | 1,612 | 200 | 302 |
| Sharon, | 408 | 15 | 94 | 10 |
| Norfolk, | 801 | 12 | 128 | 50 |
| Total, | 7,259 | 3,764 | 1,384 | 762 |
| Versicolor pheasants: | | | | |
| Sutton, | 114 | - | 5 | 4 |
| Sharon, | 16 | - | - | - |
| Total, | 130 | - | 5 | 4 |
| Reeves pheasants: | | | | |
| Wilbraham, | 4 | - | - | 6 |
| Sutton, | 57 | - | - | - |
| Sharon, | - | - | - | - |
| Total, | 61 | - | - | 6 |
| Golden pheasants: | | | | |
| Sharon, | - | - | - | - |
| Sutton, | 8 | - | - | - |
| Total, | 8 | - | - | - |
| Mongolian and half-blooded Mongolian: | | | | |
| Sharon, | 55 | - | - | - |
| Sutton, | 70 | - | 5 | 2 |
| Total, | 125 | - | 5 | 2 |
| Silver pheasants: | | | | |
| Sutton, | 10 | - | - | - |
| Half versicolor, half ring-necked: | | | | |
| Sharon, | 7 | - | - | - |
| Mallard ducks: | | | | |
| Wilbraham, | 412 | 962 | 190 | 322 |
| Sutton, | 998 | 319 | 429 | 327 |
| Norfolk, | 218 | - | - | - |
| Marshfield, | - | - | 15 | - |
| East Sandwich, | 28 | - | - | 3 |
| Total, | 1,658 | 1,281 | 634 | 652 |
| Wood ducks: | | | | |
| Sutton, | 14 | - | - | 4 |
| East Sandwich, | 20 | - | - | - |
| Marshfield, | - | - | - | - |
| Total, | 34 | - | - | 4 |
| Black ducks: | | | | |
| East Sandwich, | 24 | - | - | 12 |
| Norfolk, | - | - | - | - |
| Total, | 24 | - | - | 12 |
| Quail: | | | | |
| East Sandwich, | 1,259 | - | 377 | 4 |
| Total, | 1,259 | - | 377 | 4 |

*Game Farm Operations* — Concluded.

| | Eggs. | | Birds Liberated. | |
|---|---|---|---|---|
| | Hatched. | Distributed. | Young. | Old. |
| Turkeys: | | | | |
| Wilbraham, | 88 | – | – | 19 |
| Ruffed grouse: | | | | |
| East Sandwich, | 49 | – | 19 | – |
| Canadian geese: | | | | |
| Marshfield, | 36 | – | – | 6 |
| Norfolk, | 5 | – | – | – |
| Total, | 41 | – | – | 6 |
| Grand totals, | 10,751 | 5,045 | 2,424 | 1,471 |

*Wilbraham Game Farm.* — The work of completely equipping this large game farm was further extended under Superintendent Mosher by the erection of two new hen houses 50 by 10 feet with yards 65 by 60 feet, and by building thirty rearing coops and sixteen boxes, each containing nine nests. These boxes were arranged in tiers of four in the barn, which served as a hatch house. Experiments with metal nesting boxes proved unsatisfactory.

The grounds were improved by laying 3,361 feet of half-inch piping above earth's surface to furnish water to the various parts of the farm. Three acres of corn, 4 of oats, 7 of winter rye and 2 of buckwheat were planted, and 7 acres were ploughed. Trails were cut through the swamp in order to more easily control the depredations of foxes and other predatory animals.

*Sutton Game Farm.* — Extensive improvements have been made at this station during the past year. Superintendent Merrill has installed large permanent rearing yards for pheasants, remodeled the quail and pheasant pens, and extended the facilities for raising mallard ducks on the new hatchery grounds. He has also made the older areas more suitable, thus increasing the number of the birds that may be produced annually. The hatchery grounds have likewise been improved by clearing the woodland, constructing and repairing roads, and planting trees, chiefly fir, spruce and pine and fruit shrubs for the birds. With the installation of a new water system and extension of

the now limited grounds the hatchery should soon reach a high state of efficiency.

The new method of wintering birds for spring distribution resulted in better selection of brood stock, which in the case of pheasants means an increase in their egg production. Considerable trouble was experienced with vermin, particularly cats and crows.

Exhibits comprising a total of 881 old and 30 young birds were made at fifteen different fairs in various sections of the State.

*East Sandwich Game Farm.* — During 1915 construction work under Superintendent Torrey comprised the erection of three large wire covered quail pens, each containing 4,500 square feet, practically vermin-proof, which were situated on the southerly slope of the game farm. Fifty additional breeding coops 8 by 12 by 5 feet and fifty setting boxes also were built. The operations were especially successful with quail, but less so with ruffed grouse, which lay clutches of only 9 to 10 eggs. Considerable annoyance was occasioned by vermin, such as crows, cats, rats, chipmunks, hawks and owls, of which the Cooper hawk proved the most destructive. Over 5 acres of hay, oats, mangels, cabbage, buckwheat and winter rye were planted.

*Norfolk Game Farm.* — Under the direction of Superintendent Gates a new duck yard with four control pens, enclosing about 12 acres, has been constructed. Four new pheasant enclosures, five colony houses for hens, eighteen nurseries and twenty setting nests have been added. Considerable land has been cleared and woodland thinned for fire protection. The employment of the hospital patients at this station, which is located upon the grounds of the Norfolk State Hospital, is proving highly beneficial, both from the standpoint of the game farm and the welfare of the patients. Vermin, especially foxes and rats, were bothersome.

*Sharon Game Farm.* — The work at this place was continued under the immediate supervision of Superintendent Cushing and the direction of Dr. Field. One hundred and four pheasants were liberated and 408 were hatched. The experimental work was conducted along lines laid down in previous years.

*Marshfield Game Farm.* — Under the direction of Superintendent Sherman the rearing of ducks and geese was carried on. Most of the young birds were kept in addition to the brood stock. Mr. Sherman estimates that large numbers of quail and grouse were reared on the 5,000-acre reservation.

*Martha's Vineyard Reservation.* — Under the efficient management of Superintendent Day the work of developing the heath hen reservation has steadily progressed. More efficient fire stops have been made, 7,000 pine trees have been set out, and a large rearing pen with a concrete base as a protection from vermin has been erected for experimental work in raising these birds in captivity. Various improvements upon the barn, hen house and roads have been made, and telephone service has been installed. On the farm 22 acres have been put under cultivation, which furnish corn, rye, barley and sunflowers for the birds. The greatest depredations have come from cats and hawks. Twenty-three marsh hawks and 23 hunting cats have been shot, one cat being 32½ inches in length and weighing 10½ pounds. Eleven Canadian geese and 50 mallard ducks have been raised. Several lots of quail have been liberated and numerous nesting boxes for insectivorous birds installed.

## *Pheasants.*

It is with pleasure that your commissioners observe the increasing popularity of the pheasant as a game bird. The tameness due to the long period of protection has been succeeded by a natural wariness, and the bird has regained the characteristics which have made it so popular abroad. Eminent success has resulted from the propagation of the ring-necked pheasant at the State game farms. During the past year 2,168 of these birds have been liberated and 3,764 eggs distributed for hatching purposes.

In 1915 the open season on pheasants was the same as in 1914, but the number killed was several thousand less. The hunters invariably reported that the habits of the birds were much different than the previous year, that they were unusually shy, hiding in swamps and wet lowlands and that they were not so easily overtaken by dogs. Although it is known that

many pheasants hatched during the breeding season, heavy rains during the most critical period for the young birds were responsible for severe losses.

During the open season the automobile hunters had the great advantage of being able to cover a wide territory, and in many instances it was reported that they violated the law by shooting the birds along the highways. Numerous complaints were received concerning such automobile hunters as apparently cared little for regulations and trusted to their superior speed in avoiding not only the deputies but the people upon whose land they had trespassed. In several cases where convictions were secured the only means of identification was the automobile number.

The open season on pheasants has proved an excellent protective measure for the ruffed grouse, since many persons who were able to hunt pheasants near their homes or along the highways did not take up the more troublesome sport of tramping through the woods for partridge. Likewise, the reservations which have been made under chapter 410, Acts of 1911, have been a means of saving many pheasants and other birds which remain in such places unmolested. The best protection from poachers must be given to such areas as even property owners are excluded from hunting on these reservations.

The following table gives the number of birds killed during the open season, from October 12 to November 12, in the counties where shooting was permitted. The comparison with a similar total for 1914 is interesting, particularly in regard to the number shot the first day.

*Pheasants shot in Open Season of 1914 and 1915.*

| County. | Total. | Male. | Female. | First Day. | Second Day. | Third Day. | Fourth Day. | Fifth Day. | Sixth Day. | Seventh Day. | Eighth Day. | Ninth Day. | Tenth Day. | Eleventh Day. | Twelfth Day. | Thirteenth Day. | Fourteenth Day. | Fifteenth Day. | Sixteenth Day. | Seventeenth Day. | Eighteenth Day. | Nineteenth Day. | Twentieth Day. | Twenty-first Day. | Twenty-second Day. | Twenty-third Day. | Twenty-fourth Day. | Twenty-fifth Day. | Twenty-sixth Day. | Twenty-seventh Day. | Twenty-eighth Day. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Barnstable, | 16 | 9 | 7 | - | - | 1 | - | 1 | 2 | - | 2 | 1 | - | 1 | 1 | - | - | - | - | - | 1 | - | 3 | - | - | - | 3 | - | - | - | - |
| Berkshire, | 338 | 215 | 123 | 87 | 20 | 30 | 22 | 23 | 10 | 5 | 8 | 8 | 6 | 9 | 15 | 2 | 6 | 2 | 5 | 6 | 8 | 6 | 6 | 5 | 4 | 12 | 3 | 7 | 6 | 8 | 9 |
| Essex, | 1,460 | 903 | 557 | 267 | 113 | 83 | 59 | 127 | 64 | 49 | 35 | 44 | 28 | 56 | 32 | 27 | 20 | 38 | 31 | 55 | 26 | 25 | 21 | 24 | 21 | 39 | 25 | 28 | 27 | 36 | 60 |
| Hampden, | 254 | 172 | 82 | 50 | 18 | 13 | 12 | 31 | 12 | 2 | 5 | 6 | 4 | 8 | 11 | 6 | 4 | 3 | 2 | 8 | 2 | 1 | 6 | 9 | 7 | 12 | 3 | 8 | 3 | 6 | 2 |
| Middlesex, | 1,916 | 1,194 | 722 | 389 | 109 | 84 | 68 | 154 | 70 | 63 | 46 | 50 | 55 | 108 | 61 | 29 | 46 | 46 | 44 | 63 | 29 | 27 | 33 | 21 | 15 | 49 | 48 | 36 | 44 | 59 | 70 |
| Norfolk, | 628 | 388 | 240 | 96 | 26 | 33 | 31 | 53 | 30 | 16 | 18 | 22 | 19 | 37 | 25 | 9 | 13 | 17 | 17 | 34 | 11 | 5 | 21 | 15 | 6 | 19 | 5 | 8 | 16 | 4 | 21 |
| Worcester, | 1,229 | 764 | 465 | 167 | 62 | 48 | 49 | 89 | 55 | 55 | 30 | 35 | 39 | 77 | 34 | 34 | 42 | 37 | 41 | 35 | 22 | 14 | 16 | 27 | 16 | 38 | 21 | 21 | 31 | 37 | 57 |
| Total, 1915, | 5,841 | 3,645 | 2,196 | 1,056 | 348 | 292 | 241 | 478 | 243 | 190 | 144 | 166 | 151 | 296 | 179 | 107 | 131 | 143 | 140 | 201 | 99 | 78 | 106 | 101 | 69 | 169 | 108 | 108 | 127 | 150 | 219 |
| Total, 1914, | 8,943 | 5,805 | 3,138 | 2,034 | 770 | 158 | 12 | 15 | 398 | 414 | 456 | 390 | 333 | 279 | 499 | 265 | 207 | 172 | 196 | 154 | 304 | 148 | 167 | 143 | 148 | 150 | 266 | 148 | 157 | 237 | 323 |

*Quail.*

The first idea which one associates with the bobwhite or quail is that of a somewhat rare table delicacy or a day's sport in shooting. The fact that this quaint little bird when alive is one of our most devoted friends has never been effectively driven home to us. The very man whose interests are most benefited by the presence of the bobwhite — the farmer — is one of the class which eagerly celebrates any freedom from toil by quail shooting. Some idea of what the quail does for crops is shown by his menu, which has been most carefully studied. It includes the seeds of some of our most troublesome weeds, rag-weed, pig-weed, milk-weed, plantain, smart-weed, pepper grass, burdock, beggar ticks and many others, — a total of 139 different varieties. The number of seeds consumed by a single bobwhite in one day varies, according to the size of the seed, from 600 burdock to 30,000 rabbit's foot clover. But its diet is far from being strictly vegetarian. It consumes large quantities of insects, 145 different kinds, including potato, cucumber, bean-leaf, squash and other beetles, army worm, chinch bug, wire and cut worms, plant lice, cabbage butterfly, mosquito, cotton boll weevil and worm, striped garden caterpillar, Rocky Mountain locusts, Hessian and stable flies, grasshoppers, etc. On the other hand, the only complaint that can be made against this bird is its occasional meal of wheat grains which have been left on the ground by the reapers. According to Bulletin No. 21 of the United States Biological Survey, it is calculated that if in Virginia and North Carolina there are 4 bobwhites to every square mile, and that each bird consumes 1 ounce of seed per day, the total destruction to weed seeds from September 1 to April 30 in those States alone would be 1,347 tons. Such facts must have elaboration and emphatic repetitions in order to make the large nonhunting portion of the population realize that the preservation of the quail affects the wealth and happiness of the entire community, and therefore should be of interest not only to sportsmen but to every individual.

In 1915 quail were reported on Cape Cod, in Plymouth County and as far west as southern Worcester County, where

their number apparently is increasing rapidly. In the northern part of the State bevies of quail are comparatively few.

Sportsmen often contend that severe winters are responsible for a large per cent. of the decrease. While it is true that changed conditions of the country may make the struggle for existence more difficult, it is likewise possible to aid the birds during winter months when snow is on the ground by supplying food and grit, and by leaving patches of standing grain. Considerable work in feeding the quail with grain and grit furnished by this commission during the past winter has been carried on by farmers, fish and game associations, Boy Scouts and deputies, with the result that last spring the birds were in excellent condition. In order to increase the number of quail sufficiently to obtain effective results, more than partial protection is required.

Breeding of quail has been carried on in various States but not to such an extent as to justify the statement that the rearing of these birds has passed entirely beyond the experimental stage. In habit it is primarily monogamous, and the breeding stock should be paired off and put in breeding pens in April. Bantam hens have proved most effective for hatching and brooding. A number of precautions are necessary for successful rearing. Broods must be carefully protected against vermin by general methods, such as trapping and shooting, and by properly constructed wire fences. Each pen should be provided with brush or deep grass, as quail are naturally shy creatures. The pens should be moved daily, or every other day, so that the ground may not become fouled. Young quail should be fed very lightly, but often, on a general diet of boiled eggs, milk curd or some animal food, such as ant eggs. At the end of the first week a little grain is introduced and the quantity gradually increased. While the hens are not needed for brooding after the young quail attain an age of eight or ten weeks, they are helpful in holding the brood together, and thus defer the time of confining the birds in pens.

State propagation of this bird at the present time is confined almost exclusively to the East Sandwich game farm, from which 377 young and 4 old quail were liberated in 1915. The eggs are hatched under bantams, which are allowed to roam

with the quail chicks when twelve days old. At the end of six weeks the young are caught, often with difficulty, and shipped for distribution.

Quail reared in confinement are largely lacking in stamina, which renders them susceptible to disease, as well as to losses from weakness and debility. In some measure this may be avoided by careful diet and stimulating exercise. In order to determine the best methods of overcoming this lack of stamina the following experiments in the open method of rearing quail were conducted at the Sutton game farm. In these tests flocks of different ages were given their liberty in the care of bantam hens under varied conditions.

1. Nine quail three weeks old were located near some flower beds, where they remained, rarely making excursions into the surrounding territory. Four died from poisoning, the remaining 5 were recaptured.

2. Thirty-two birds two weeks old were placed on a brush hillside near an open grass plot. At first they exhibited considerable wildness, rarely venturing into the open, but gradually they became tamer, and left their hiding places at feeding time. Later, 20 were taken in a trap which consisted of a light frame and netting, set with a figure four trigger. Four died from poisoning and eight escaped from the main flock.

3. Thirty-two birds were placed in an open field near a drainage ditch which afforded but slight cover. With increasing strength they took long flights, seeking cover outside of the field, and their wildness steadily increased. Whenever approached by the attendant at feeding time they took to wing and scattered widely, but speedily returned when no one was in sight. Their number was seriously reduced by the death of several from unknown causes and by the escape of many others. Thirteen which were recaptured soon lost their natural wildness after being confined in coops.

4. Fifteen birds were located in a distant, weed-grown cornfield, where 12 grew to a size sufficient for recapture. Unfortunately, the brood hen died, and the young quail, being on less friendly terms with the new hen, departed from the coop. Eight were caught, but 4 avoided the traps and soon disappeared.

5. Fifteen birds which were placed in a potato patch where buckwheat gave additional cover took flight when encountered upon open ground. Just previous to the time of capture they suffered from the depredations of a cat, and only 9 were recovered.

6. Twelve birds were placed in a cornfield near a plot of uncut grass, where, owing to the large area and numerous opportunities for hiding, they quickly grew tame. They were taken up at a younger age than the other lots as a cat was discovered hunting in their vicinity.

7. Nine birds, which were located on a grass plot, preferred to keep in hiding rather than venture upon open land.

8. Later, 12 birds were placed in the same cornfield as the fourth lot. Five soon died from intestinal trouble of an amœbic nature, and the remaining 7 gradually disappeared.

9. Twenty-one birds were placed with 2 hens in a field of millet with a neighboring lot of broom corn and rape. These birds soon mingled, sometimes in one coop, sometimes in the other. They gradually decreased in numbers, possibly owing to hunting cats which were observed in the vicinity. Sixteen were finally recaptured, the last being killed in the trap by a cat which was eventually shot after having destroyed 5 young birds. As a result of outdoor rearing these quail, although not hatched until September 12, gave promise of becoming large, strong birds by winter.

10. Twenty birds, which were held in coops until eight weeks old, were liberated in order to improve their condition for wintering. These older birds acted entirely different from the younger, and separated into small flocks which ranged over an extensive tract of brush land. Ten which fed around the coops of penned quail were recaptured, and about the same number wandered away. Evidently, in order to colonize quail in any desired locality it is necessary to put them out at an early age.

Our experience with these birds indicates that whenever thick cover is near by the birds have a tendency to become tame; but if they have to seek distant hiding places they soon become wild. Unlike pheasants, which rush to their pen when alarmed, the quail seeks to hide outside, and they are even disinclined to return to their bantam foster mother at night. In mild

weather no harm results from this habit, but in cold weather there is danger that the birds may perish.

On the other hand, the home instinct is so strong with quail that field growing is more practicable than with pheasants. The rallying point of a scattered flock of quail is the coop or place where they have been accustomed to feed, whereas with pheasants there is no strong attachment to the home, and when beyond the age that shelter is required the birds do not return to the coop. The disadvantages of field work with quail are due mainly to their persistence in remaining near their home place when hunted, and their useless habit of "freezing."

Their skill in selecting all possible cover, at which they are more adept than pheasants, proves a helpful protection from hawks. When first put out they venture into the open only with utmost caution, skulking in all available cover, and darting across open spaces as quickly as possible. When fed in the open they alternately feed hastily and hide, and therefore they should be fed in places provided with proper cover. Cornfields, better if weed-grown, and grass fields with unmowed strips, especially near fences, are excellent places.

### *Ruffed Grouse.*

With but few exceptions ruffed grouse are reported to be on the increase in all sections of the State, and the number seen since the hunting season closed augurs well for a good supply. From the East Sandwich game farm 19 young were distributed from a hatching of 49 eggs. These birds are exceedingly difficult to raise artificially, and their propagation is still a matter of experimentation.

### *Ducks.*

The beautiful wood duck is as plentiful as last year, with no great increase being reported for any section. It is sincerely to be regretted that this species does not more readily lend itself to artificial propagation. Last year only 4 birds were distributed, although 34 were hatched at Sutton and East Sandwich.

Black ducks are said to be on the increase on Cape Cod, Nantucket and Martha's Vineyard, where as many as 600 at

one time were observed feeding on Katama Flats. These birds are reared in small numbers at the Wilbraham, East Sandwich and Norfolk game farms.

Redheads and bluebills were abundant on Martha's Vineyard, 2,000 having been reported at Job's Neck Pond, — a larger number than had been observed for years. Also, 3,000 and 2,500 were observed Nov. 1, 1915, in Tisbury Great Pond and Pocha Pond, and later, 2,000 at Sengakontacket Pond.

Mallard ducks have proved well adapted for artificial propagation. During the past year 1,286 have been liberated, chiefly from the Wilbraham and Sutton game farms.

### *Geese.*

Last year the flight of geese was much later than usual, and when the birds arrived many of the inland waters were frozen over. The season was considered a failure at many gunning stands, notably on Martha's Vineyard, where only 25 per cent. of last year's flight was observed. At certain ponds where the birds formerly congregated they did not stop at all, while other places, where a heavy flight is unusual, were favored with the best in years.

### *Marsh and Shore Birds.*

These birds do not visit our shores in any great numbers during the hunting season. Good flights were reported on the northern migration, but for some reason they did not return this way. Reports indicate that there were not as many shore birds as usual. The only noteworthy increase appeared in the smaller varieties, which are protected by the Federal law. Nantucket was the only section which could boast the usual number of shore birds. Reports from the northeastern part of the State say that snipe are more plentiful than they have been for years. Upland plover are still very scarce.

The colony of least tern on Katama Beach has extended along the shore for a stretch of 6 miles, instead of segregating in their former limited areas, but the birds appear less numerous than last year. The Wilson tern, which nests on the sandy beaches at Edgartown and Tisbury Great ponds and along the south shore of Martha's Vineyard and on Muskeget Island, are more numerous than ever.

### *Woodcock.*

Woodcock are reported to be very scarce and there appears to have been only one heavy flight during the fall of 1915. A few have been bred locally, but not enough to make any material difference in their number.

### *Heath Hen.*

The heath hen is steadily showing a decided increase on Martha's Vineyard where their number is now estimated at 2,000. In view of this surprising increase the proper time may be at hand to attempt their transplantation to other reservations on the mainland. The birds are reported by Superintendent Day as covering the entire island, with the exception of Gay Head. He heard the first "booming" on February 22 and saw the first covey of 6 chicks on June 19. Efficient protection is beginning to yield fruitful results in the preservation of this interesting and important game bird.

### *Song and Insectivorous Birds.*

In all sections these birds are reported as more numerous than for many years, in spite of the fact that the spraying of trees with poisons has been responsible for many deaths.

### *Deer.*

Deer are reported as particularly abundant in Berkshire, Franklin, Hampshire and Hampden counties, but less numerous in the eastern part of the State. During the open season about the same number were killed as last year, the weather conditions of the first day being responsible for the smaller bag. Little variation from last year is shown by our records as to the deer killed, the number seen or the damage to crops, but as a whole we have had more complaints of dogs chasing deer than ever before. A remarkable albino deer was reported killed. On December 24 Mr. R. D. Beman of Westfield killed a doe with horns several inches in length, which were still in the velvet. During the open season 11 deer less than 100 pounds were killed, the smallest weighing 75 pounds. The largest deer, weighing 400 pounds, was killed in Montague by Mr. Edward Dubrey of Athol. One hundred and fifty-two

deer between 200 and 300 pounds, and 19 between 300 and 400 pounds, were killed. Eight deer were shot by women.

The following tables present the deer statistics for 1915: —

*Deer shot during the Open Season of 1915.*

| Counties. | Male. | Female. | Sex unknown. | Wounded. | Killed. November 15. | November 16. | November 17. | November 18. | November 19. | November 20. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Barnstable, | 11 | 14 | 3 | 1 | 3 | 3 | 4 | 8 | 2 | 8 | 28 |
| Berkshire, | 118 | 84 | 3 | 2 | 38 | 36 | 41 | 23 | 31 | 36 | 205 |
| Bristol, | 21 | 21 | 3 | – | 8 | 11 | 2 | 5 | 6 | 13 | 45 |
| Dukes, | 3 | – | – | – | – | – | – | 3 | – | – | 3 |
| Essex, | 8 | 5 | 1 | 1 | 6 | 1 | – | 2 | 1 | 4 | 14 |
| Franklin, | 102 | 92 | 10 | 3 | 55 | 50 | 24 | 22 | 23 | 30 | 204 |
| Hampden, | 83 | 67 | 1 | 2 | 27 | 30 | 25 | 19 | 22 | 28 | 151 |
| Hampshire, | 99 | 62 | 7 | – | 24 | 45 | 33 | 19 | 19 | 28 | 168 |
| Middlesex, | 26 | 16 | – | 1 | 6 | 6 | 7 | 3 | 6 | 14 | 42 |
| Norfolk, | 3 | 4 | – | – | – | 3 | 1 | – | 1 | 2 | 7 |
| Plymouth, | 26 | 28 | 2 | – | 20 | 13 | 6 | 4 | 4 | 9 | 56 |
| Worcester, | 106 | 67 | 6 | 4 | 38 | 42 | 23 | 17 | 14 | 45 | 179 |
| | 606 | 460 | 36 | 14 | 225 | 240 | 166 | 125 | 129 | 217 | 1,102 |
| Unclassified, town not reported. | – | 2 | 1 | – | – | – | – | – | – | – | 3 |
| | 606 | 462 | 37 | 14 | 225 | 240 | 166 | 125 | 129 | 217 | 1,105 |

*Summary and Comparison of Deer Statistics, 1907–15.*

| | 1907. | 1908. | 1909. | 1910. | 1911. | 1912. | 1913. | 1914. | 1915. |
|---|---|---|---|---|---|---|---|---|---|
| Deer seen, | 1,298 | 2,035 | 1,594 | 2,582 | 1,608 | 1,120 | 872 | 523 | 664 |
| Seen chased by dogs, | 114 | 120 | 71 | 26 | 10 | 13 | 5 | 4 | 6 |
| Seen damaging crops, | 85 | 100 | 227 | 358 | 242 | 220 | 153 | 214 | 237 |
| Shot illegally, | 40 | 36 | 49 | 64 | 30 | 23 | 13 | 5 | 4 |
| Killed by trains and trolley cars. | 25 | 60 | 55 | 50 | 25 | 35 | 14 | 25 | 20 |
| Dead from other causes (dogs, drowning, etc.). | 47 | 83 | 82 | 157 | 77 | 126 | 109 | 118 | 76 |
| Shot while damaging crops, | 16 | 17 | 198 | 327 | 232 | 313 | 195 | 212 | 254 |
| Total, | 1,625 | 2,451 | 2,276 | 3,564 | 2,224 | 1,850 | 1,361 | 1,101 | 1,261 |
| Total killed in open season, | – | – | – | 1,281 | 1,270 | 1,231 | 1,596 | 1,312 | 1,105 |
| Total wounded in open season. | – | – | – | 101 | 56 | 53 | 34 | 21 | 14 |

*A Comparative Statement of Payments on Account of Damages by Wild Deer in the Fiscal Years 1910–15.*

| Counties. | 1910. | 1911. | 1912. | 1913. | 1914. | 1915. |
|---|---|---|---|---|---|---|
| Barnstable, | - | $12 00 | $149 25 | $4,587 00[1] | $147 00 | $18 00 |
| Berkshire, | $452 40 | 373 00 | 347 00 | 442 50 | 476 50 | 207 00 |
| Bristol, | 124 75 | 99 00 | 770 00 | 297 00 | 173 50 | 213 00 |
| Essex, | 286 00 | 445 60 | 382 05 | 287 50 | 243 85 | 43 00 |
| Franklin, | 3,363 10 | 2,905 35 | 5,523 25 | 3,846 72 | 3,644 21 | 3,440 61 |
| Hampden, | 779 00 | 1,588 05 | 2,055 70 | 2,401 15 | 1,786 87 | 1,417 23 |
| Hampshire, | 585 90 | 2,556 67 | 1,720 43 | 1,644 58 | 1,126 85 | 750 02 |
| Middlesex, | 879 73 | 605 65 | 887 00 | 1,541 50 | 418 50 | 666 00 |
| Norfolk, | 9 80 | 79 00 | 294 25 | 184 00 | 126 00 | 93 00 |
| Plymouth, | - | 251 00 | 261 50 | 562 34 | 61 25 | 6 00 |
| Worcester, | 871 16 | 611 50 | 2,566 50 | 2,606 10 | 838 95 | 1,251 80 |
| Fees to appraisers and chairmen. | - | - | 725 20 | 1,576 90 | 940 00 | 1,027 15 |
| | $7,351 84 | $9,526 82 | $15,682 13 | $19,977 29 | $9,983 48 | $9,132 81 |

[1] Two claims included in this amount aggregate $4,404.20.

## *Rabbits.*

These animals have shown a general increase, and are especially abundant in the western, northern and southeastern parts of the State. Berkshire, Franklin, Plymouth, Nantucket, Hampshire, Hampden, Bristol and northern Worcester counties report a plentiful supply. In some instances they have multiplied so rapidly as to become a nuisance to farmers, owing to the destruction of young fruit trees.

## *White Hares.*

This excellent game animal is reported as scarce throughout the State, a condition which is probably due to the increase of foxes and to a knowledge of its habits, since the white hare is now exclusively hunted in swamps. Individuals from a consignment liberated by this commission in Norfolk County were later reported to have attained large size. There is urgent need of protection for this animal during the entire year. At the Wilbraham game farm 181 were liberated in

the swamp in 1914, and were fed with clover, hay, beets, cabbage and apple tree twigs. Of these, 97 were distributed in other parts of the State, where the natural surroundings, such as cedar swamps, were favorable for their existence.

It is the aim of your commission to introduce this animal wherever expedient, and by protection to give it a chance to propagate, thus assuring excellent gunning for the sportsmen. These hares have acquired a reputation of being one of the best sporting animals, for the reason that, unlike the small coney they do not hole up when pursued. They are long-distance runners and will afford a most excellent chase, and while it is true that they strip some of the forest brush during the winter season, as far as we have been able to ascertain they do no appreciable damage to the fruit trees in the regions where they are found in the largest numbers.

### *Gray Squirrels.*

Invariably gray squirrels are said to be on the increase throughout the State, with the exception of the eastern counties, to such an extent that in one locality they are considered pests.

### *Foxes.*

Apparently the number of foxes is steadily increasing in all sections, chiefly owing to the restrictions put on trapping and the increase of wild game birds and small animals. We have very little information relative to the number of fur-bearing animals killed, or the value of the skins. The fur market is many times over-supplied with inferior pelts, which tend to reduce the price on the better grades of furs.

## Marine Fisheries.

Massachusetts has at her very doors wonderful facilities for the development of marine fisheries. From her superior geographical position she has always been, and always will be, a fishing State. With the two large fish markets of Boston and Gloucester, and with the large fleet of fishing vessels from these ports, the deep-sea fishing industry of Massachusetts constitutes an important factor in the general welfare of the

Commonwealth. Likewise, along the coast the shore fisheries provide a means of livelihood for thousands of fishermen. The main object of your commissioners is to encourage in every way the development of the various fishing industries, and at the same time to make possible the conservation of important resources of the sea for our descendants. Handicapping fishing industries by rigidly restrictive laws is uncalled for, unless it is apparent that the future supply of fish is being imperiled, while every movement toward the betterment of the industries should be encouraged. Obtaining statistics, advice as to the regulation of the different industries, settling disputes among different classes of fishermen, oversight of the sanitary conditions of the fisheries in the interests of the public health, and the education of fishermen by reports, lectures and other means of instruction, now constitute in part the duties of this commission. We strongly recommend that there be established a fisheries institute or school for the practical education of the fishermen, such as is now conducted in Japan. The possibilities of developing the shore fisheries should be brought to an active state of realization by the establishment of a system of sea farming, whereby the fishermen may be able to cultivate sea products on an equal basis with the agriculturist.

*Fishermen.* — The past ten years has witnessed a decided improvement in the lot of the average fisherman. The life of the fisherman is by no means a sinecure, and his occupation often calls for hard, concentrated work under trying conditions. Many steps have been taken toward the alleviation of the unpleasant features of the average fisherman's life, such as hospital ships, increased accommodations, better and safer types of fishing vessels, and various places of recreation on shore.

The deep-sea fisherman is exposed to the dangers of the sea and the inclemency of the weather. His returns are, in a certain sense, a lottery, a fact that gives an added attraction to fishing. He works strenuously at times, and then remains comparatively idle until the next period of active work.

Shore fishing, which is confined chiefly to handline, net and mollusk fishing, with catboats or small motor boats, is less

exacting. As a rule, trips are made for the day, and the fisherman can return to a comfortable home at night. During the winter any type of fishing is difficult, but the life of the shore fisherman is infinitely more pleasant than that of his deep-sea brother. The personnel of the fishing industries, particularly the deep-sea, has undergone a slow but progressive transition, and the native New England fisherman has been largely supplanted by men of foreign birth. The nationalities represented in the fishing business at the present time are principally Portuguese, Italians, Greeks and Canadians from Nova Scotia and Newfoundland, who during a portion of the year engage in the deep-sea and trap fisheries of Massachusetts. Apparently within another generation few men of old New England stock will be engaged in the fisheries.

For a long time fishermen as a class have looked upon the laws regulating the fisheries as special efforts on the part of the fish and game commission inimical to their welfare, an idea which has been fostered possibly for political reasons. This department has endeavored to overcome this prejudice through the education of the fishermen, in order that they may decide for themselves what laws are necessary for the protection of the fishing industries. It is only through the concentrated effort of all classes of fishermen for the enactment of rational legislation that the interests of the fisheries can best be served. The organization of the different associations, especially among the lobstermen, is perhaps the greatest improvement that has occurred in the past ten years. It means the education of the fishermen, general improvement of fishing conditions, the passing of proper laws, and the development of the fishing industry, as well as the betterment of the individual fisherman.

### *Deep-sea Fisheries.*

*Boston Fish Market.* — An important recent development in the commercial fisheries has been the completion of the new fish pier near the Commonwealth Pier at South Boston, affording the latest and most up-to-date facilities for the sanitary handling of sea food. In this respect, perhaps, if not in convenience for the fishermen, it is vastly superior to the old

T Wharf, which had long shown itself inadequate and unsuitable for modern effective sanitary conditions.

Work was started on the new fresh-fish market in 1910, and by April, 1914, practically all the firms had moved from the old location. This wholesale center of Boston's sea fisheries is well worth a visit. The pier itself, constructed of concrete, is 1,200 feet long by 300 feet wide, providing dock accommodations for forty fishing vessels. A great midway runs down the center, flanked on either side by a row of two-story buildings. The cold storage and power plant are at the head of the pier, while at the end is located the exchange room, the offices of the exchange and corporation, and the offices of the Boston Fish Bureau and commission merchants. The entire property comprises 537,100 square feet and contains 44 fish stores. The buildings are thoroughly hygienic, constructed of cement, brick and glazed tile, in keeping with the requirements of the board of health, and absolutely fireproof. Artificial ice to an amount as great as 800 tons can be made daily for delivery to the ships from the storage plant, an eight-story building, where the ice is cracked by machinery and shot down a chute into trucks for its final disposal. A storage room 60 feet high, with a capacity of 17,000 pounds, contains reserve ice. Ample storage room for all fish and perishable products is provided, and light, heat and water pressure are provided for the whole pier.

The individual fish markets are well ventilated, and have concrete floors and walls which can be thoroughly flushed with running water. In these wholesale markets the fish are brought from the vessels, weighed, graded and packed for distribution. The shops use the ground floor for storage and packing, and the upper floor for the accounting office. In the midway the delivery drays back up to receive the fresh packed fish, and rush them to the express cars or to the retail markets of Boston.

Unquestionably the sanitary and even æsthetic precautions in marketing fish will increase many fold the future fish trade of Boston. The community is to be most sincerely congratulated upon the enterprise and wise foresight of the leaders in the fish business of Massachusetts.

*Gloucester.* — Gloucester has retained her supremacy in the salt-fish industries, and ranks second only to Boston as a fresh-fish center. The year 1915 showed an 18,000,000 pounds increase over the previous year in the total quantity of fish landed at her docks. Improvements are being steadily made in all branches of her fishing industries.

The successful operations of the past year were accurately and well described in the following extract from the "Gloucester Daily Times:" —

The summer proved one of the most prosperous in the history of the city. Money was plentiful and the result was felt by all.

The total amount of fish landed here last year is estimated at 111,004,775 pounds, or more than 18,000,000 pounds more than in 1914, which was considered a most satisfactory year. The value will reach many millions of dollars. The fish not the product of American fisheries received here last year was about the same quantity as in 1914, so the Gloucester vessels profited by the heavier total receipts.

The mackerel fishery was responsible for a large part of the increase. The catch of fresh mackerel landed here is estimated at 12,409 barrels, against 3,184 barrels in 1914. The salt mackerel brought in here in 1915 was 16,609 barrels, against 13,895 barrels in 1914.

Prices for all kinds of fish were good throughout the year, and as a result many fine stocks and shares were made by the vessels and crews, and the year was one of general prosperity for the fishing fleet.

Detailed information on the fishing fleet, the big fares, where the vessels fished, and the fine stocks and shares, is given in the following résumé: —

*The Mackerel Fleet.* — The mackerel seiners had the best season in recent years, and never before were mackerel any more plentiful in Massachusetts Bay, and it was this branch of the fisheries that contributed to the greatest extent in the prosperity that was enjoyed in this city during the summer and fall. Not only did the sailing vessels do exceptionally well, but the fleet of little steamers reaped a harvest. The only unfortunate thing about the mackerel fishery in 1914 was the failure of the North Bay trip, so that vessels that went to the northward lost much of the fall run of mackerel that added greatly to the already large stocks of the vessels that remained in local waters.

The southern fishery was the best since 1907.

The fleet that went to the southward numbered 20 sail and was early in getting away. Schooner "Ralph L. Hall," Capt. Frank Hall, was the first to sail, leaving here March 29, and was followed in a few days by the entire fleet.

The vessels ran into a heavy blizzard April 9 and the damage was heavy. Schooner "Arthur James" and schooner "Pythian" each lost a seine boat,

and schooner "Monarch" was considerably smashed up. Others of the fleet incurred lesser damage.

The first fish were landed April 8, by schooner "Rob Roy," Capt. Lemuel Firth, who had 44 barrels in Lewes, Del. The next day schooner "Ralph L. Hall," Capt. Frank Hall, was in New York with 20,000 mixed mackerel. This was thirteen days earlier than the first fare in 1914.

The largest single trip of the southern season was 50,000 fresh mackerel, landed in New York, April 21, by schooner "Arthur James," Capt. John Matheson.

The high line on the southern trip was steamer "Lois H. Corkum," Capt. William Corkum, whose stock was $8,885.74, and the share of the crew $329 each. This was a fine beginning for the year's work, and the little steamer continued to bring in good trips through the season, so that at the end of the year she was high line of the fleet. The steamer's stock on the southern trip was the highest since 1907, and the share of the crew broke all previous records for this trip.

Schooner "Arthur James," Capt. John Matheson, was in second place on this trip, with a stock of $8,854.34, and the share of each of the crew $185.54.

Not only the seiners but also the netters enjoyed an excellent year out south. The fleet was a large one and the market was kept well supplied. The trips were usually of good size. On May 17, after the seiners had returned to fit here for the Cape Shore, there were 52 netting fares in Fulton Market, with a total of 106,000 pounds of fresh mackerel.

The Cape Shore season was a great success, and some of the vessels after landing one good trip returned and secured a second, while others went down for the third.

The fleet left here about the 20th of May and the first returned June 7. The vessels to arrive on that day were schooner "Arthur James," with 55,000 fresh and 155 barrels of salt; schooner "Fannie A. Smith," Capt. Wallace Walker, with 38,000 fresh and 175 barrels of salt; schooner "Lottie G. Merchant," Capt. Ralph Webber, with 40,000 fresh and 175 barrels of salt; schooner "Rob Roy," Capt. Lemuel Firth, with 56,000 fresh and 135 barrels of salt; schooner "Monarch," Capt. John Seavy, with 36,000 fresh and 250 barrels of salt; schooner "Victor," Capt. Douglass McLean, with 35,000 fresh and 140 barrels of salt; schooner "Norma," Capt. John McKinnon, with 40,000 fresh and 12 barrels of salt; schooner "Benjamin A. Smith," Capt. Martin L. Welsh, with 45,000 fresh and 145 barrels of salt.

There was another large list of arrivals the following day, and within a short time the entire fleet had returned with good trips.

The highest stock on this single trip to the Cape Shore was made by schooner "Monarch," Capt. John Seavy. The stock was $5,110, and the share of the crew $100.75.

The price paid for Cape Shore salt mackerel was $8 per barrel, a decrease of $2 per barrel from the first price of 1914.

The following vessels returned for a second trip to the Cape Shore and were successful in getting good fares: schooner "Arthur James," schooner "Rob Roy," schooner "Monarch," schooner "Constellation," schooner "Marguerite Haskins" and schooner "Saladin." Schooner "Arthur James" and schooner "Rob Roy" went down for a third trip. The former was successful in getting a small fare.

Some authorities claimed that the 1915 Cape Shore season was the best in fifty years. It is safe to say that it was by far the best in recent years, one of the best features being the fact that nearly all the vessels got good trips, which is sometimes not the case.

After the return of the fleet from the Cape Shore the vessels found fairly good fishing and continued to add to their stocks. The price of salt mackerel was steadily increasing, and for that reason the captains preferred to salt their catches rather than run fresh to market.

By August 5 the price of salt mackerel had risen to $15.50, that price being paid for a trip of 100 barrels of schooner "Arthur James."

The fish were plentiful on Georges during July, but a series of storms in the early part of August broke the schools up and the fares were rather small for some time after.

While the fish disappeared from Georges they came in vast numbers to the shore. The little steamers brought in big loads, mostly blinks and tinkers, and sold to local dealers for 2½ cents per pound.

September 1, steamer "Thelma," Capt. Elroy Prior, landed a monster trip of 43,000 pounds of tinkers and blinks, taken off Boston Light. The fish sold to split at 3½ cents per pound.

Another example of how plentiful fish were is shown by the work of steamer "Roland Wilcox" on same day. In the forenoon she was at the new Boston pier with 15,000 fish, and quickly discharged to get underway again. At 11 o'clock at night Captain Wilcox returned for the second time, bringing a big catch of 32,000 mixed fresh fish.

The spurt kept the local mackerel splitters busy, and the firms were able to get some fish which they needed.

Remembering the success of the fleet in the North Bay in 1914, and thinking that the fish had gone from the shore, a few vessels left about the first of September for the bay, although the fleet was not so large as in 1914, numbering 6 sail. Later events showed that they would have done much better by remaining on the shore, as the bay trip was a failure, while the mackerel reappeared on the shore in large numbers.

Those who did not go to the bay remained out, and although no large trips were landed, good prices paid for salt mackerel helped to swell the stocks and make the trips profitable to the crews. On September 17 salt mackerel was bringing $17.50 for large and $8.50 for small.

The first large trip to follow the disappearance of the fish in August was brought in September 17 by schooner "Constellation," Capt. Charles Maguire. The hail was for 40,000 pounds of fresh mackerel and 110

barrels of salt. The fish were taken off Race Point. The stock on this trip was over $3,000.

This trip gave the fishermen more encouragement, especially as two days after schooner "Benjamin A. Smith," Capt. Martin L. Welch, brought in a $3,400 trip of 240 barrels of salt mackerel.

The good trips continued through September and October, but the climax came the last part of the month, when record trips were brought in by three vessels.

On October 23 schooner "Constellation" landed a trip of 400 barrels of salt mackerel, from which the stock was $6,521 and the share of the crew $143. This was the largest stock of the season, although it was equaled a few days later.

Three days later, before the water front had ceased to talk of Captain Maguire's trip, schooner "Volant," in command of Capt. John F. Vautier, arrived with 75,000 pounds of fresh fish and 210 barrels of salt. She arrived Monday night, October 25, and immediately a crowd gathered at the Pew Wharf of the Gorton-Pew Fisheries Company, where she tied up. The trip was the largest in years and one of the largest on record; the scuppers of the vessel were nearly on a level with the water, while every available space on deck was full with the fish. In fact, she had all she could carry. The trip was taken in Boston Bay, where others of the fleet and the steamers got fine hauls. The stock was $6,521 and the share was $150, the largest for a single trip for many years.

Schooner "Victor," Capt. Douglass MacLean, was soon along with another monster trip. On October 27 he arrived at the wharf of Davis Brothers, hailing for 80,000 pounds of fresh mackerel and 70 barrels of salt. This was an even larger trip of fresh mackerel than that of the "Volant," but the stock was not so large, being $3,488. The fish sold to split. It is believed this was the largest trip of fresh mackerel ever brought in here. They were taken on Middle Bank.

The fall run of mackerel was the best in several years and thousands of dollars were added to the stocks and hundreds to the share of the crews. Money was very plentiful in this city for several weeks following the mackerel run.

The small boats also came in for their share, and as they were manned by fewer men the share each man received was much greater than those on the larger vessel. Each of the crew of the schooner "Little Fannie," Capt. Charles Nelson, in three trips made in five days in the latter part of October, shared $326.50, believed to be a share record at any kind of fishing.

Many similar cases might be given of the results of the good trips.

Schooner "Arthur James" returned from the North Bay just in time to secure one trip of salt mackerel off the shore. This trip, which was the last of the season, resulted in a great jump in the price of salt mackerel. There were 188 barrels of tinkers and 15 barrels large fish in the trip. After 74 different offers the fish were sold for $28.50 per barrel for large and $14.50 for tinkers.

The high line of the seining fleet was steamer "Lois H. Corkum," Capt. William Corkum, whose stock was $33,200 and whose crew shared $1,100.50. This stock was the largest for several years, and the share, because of the small number in the crew, was the largest ever made by a seiner in one season.

Close behind the steamer was schooner "Lottie G. Merchant," Capt. Ralph Webber, whose stock was $33,000 and whose crew's share was $700. Captain Webber had some fine trips during the fall, and it is estimated that his stock was over $10,000 from September 1 to November 1.

Other good stocks were made by schooner "Monarch," Capt. John Seavy, which had $28,884; schooner "Marguerite Haskins," Capt. Reuben Cameron, $28,809; schooner "Arthur James," Capt. John Matheson, $26,950; schooner "Rob Roy," Capt. Lemuel Firth, $26,158. A number of others had stocks in the vicinity of $20,000.

*The Haddocking Fleet.* — At the beginning of the year there was a fleet of about 40 vessels, including the channel fishermen, engaged in the haddocking branch. The off-shore fleet, almost without exception, brought in excellent trips, but the prices were very low; in fact they were at times no better than those paid here by the splitters. But few fares were brought here, however, the fishermen preferring to fit in Boston and save time.

About the last of January prices began to improve, and some of the vessels realized neat stocks and shares.

The best haddocking trip of the winter was made by schooner "A. Platt Andrew," Capt. Wallace Bruce, who landed February 3, 90,000 pounds of fish, from which the stock was $4,050 and the share of each of the crew of 25 men $90. The largest trip of the winter in the amount of fish was on January 8, by schooner "Laverna," Capt. John McInnis, hailing for 135,000 pounds, part of which was brought here to split.

The work of Capt. Wallace Bruce, in schooner "A. Piatt Andrew," stands out prominently in the results of the past year in the haddocking branch. From January 1 to April 1, when the vessel shifted to shacking, nearly 700,000 pounds of fish had been landed by that craft. Capt. Bruce's year is from September to September. In those twelve months he stocked $48,669, and each of the crew shared $880. From January, 1915, to January, 1916, it is estimated that this vessel landed 2,000,000 pounds of fish at Boston and this port. About 1,810,000 of this was fresh.

Schooner "Pontiac," Capt. Ernest Parsons, led the channel fleet for the year, and it is estimated that the vessel landed over 1,600,000 pounds of fresh fish last year.

The first trip from the Peak was brought in by schooner "Esperanto," Capt. Asa Baker, March 8. The vessel hailed for 112,000 pounds. Other trips from these grounds followed, and a large proportion found their way to the splitters in this city.

Schooner "Mary F. Sears" was the first of the Portuguese shore fleet to go off-shore in the spring. She arrived in Boston March 8 with a fare

of 90,000 pounds. Soon after the others of this fleet left the shore and made good trips to the northern edge of Georges and Western Bank.

Haddock struck in March 24, and soon prices on this species fell to a nominal figure, being often quoted at the Boston fish pier at $1 a thousand.

The steam otter trawlers profited well by the spring run of haddock, and on the southeast part of Georges fares of 100,000 were not uncommon. The steam trawler "Long Island" on April 6 landed in Portland a fare which hailed for 225,000 pounds. Portland took a large number of trips of the beam trawlers last year, and in one day alone handled 565,000 pounds from the steamers.

*Trawlers.* — The trawlers were here very often last year disposing of their fares to the splitters. The trawler "East Hampton" later in the year, on July 20, landed at the plant of Cunningham & Thompson what is believed to be the largest fresh-fish fare ever arriving in one bottom. She hailed for 310,000 pounds of fresh fish.

The haddock fares of the beam trawlers during the spring and summer ran from 20 to 40 per cent. "scrod" or immature fish, and in some cases even more.

About April 1 nearly all the fleet made one trip to the Peak before coming to this port to fit for the Cape North trip. A few of the fleet changed to halibuting at this time.

The first to leave for Cape North was schooner "Stiletto," Capt. Lyman Wyldes, on April 13. As is usually the case, the shackers at this time began to feel the shortage of men, and many were delayed in sailing because they could not obtain a full crew.

After the fleet had sailed it looked very much as if the season would be the repetition of 1914, which was a failure. The ice was late in leaving and the bait reports were very favorable.

On April 26 the first vessel reached the Magdalenes, but it was not until June 2 when schooner "Governor Foss" arrived here with the first trip of the season, hailing for 80,000 salt and 120,000 pounds of fresh fish. She was in the ice nineteen days, and others of the fleet were in for a much longer time.

When the vessels were at last able to begin operations they found fish very plentiful and almost without exception excellent trips were brought home.

The largest stock on this trip was made by schooner "Arethusa," Capt. Clayton Morrissey. The hail was for 110,000 of salt fish and 110,000 pounds of fresh. The stock was $5,826 and the crew's share $120.

Other vessels which stocked over $5,000 on this trip were schooner "Stiletto," Capt. Lyman Wyldes, $5,600; schooner "A. Platt Andrew," Capt. Wallace Bruce, $5,504; schooner "Sylvania," Capt. Jeff Thomas, $5,730; schooner "Conqueror," Capt. Robertson Giffin, $5,240; schooner "Onato," Capt. J. Henry Larkin, $5,741; schooner "Thomas," $5,790.

Encouraged by the fine showing made on the Cape North trip, the shackers next fished off Perce, and some big trips of shack were landed

here for several weeks after. The largest fare from these grounds was brought by schooner "Thomas S. Gorton," hailing for 200,000 pounds of fresh fish and 30,000 pounds of salt. The stock was $4,633. Some of the vessels made two trips to these grounds and each time secured fine fares.

Some very large trips of fresh fish were brought in here during the remainder of the summer, the largest hail being for 210,000 pounds, made by Capt. Lyman Wyldes in schooner "Stiletto." The trip was taken on La Have. Trips hailing for 175,000 to 200,000 pounds were not uncommon.

After enjoying a good summer, the vessels began about the middle of September to fit again for winter haddocking. The vessels went to the channel, but the season here was a failure, the trips being very small. The fleet did not wait until Thanksgiving before leaving these grounds, and early went to the eastward, where better fishing was found. Up to the close of 1915 there had been few very large trips landed.

The Provincetown fleet did well again last year, although the record stocks of 1914 were not reached. Schooner "Mary C. Santos," which was probably high line of that town's fleet, cleared up about $43,000 for her season's work.

*Halibuters.* — The fleet of fresh halibuters had a good year, and many vessels made good stocks and the crews profited by good shares. At the height of the season there were about 30 sail of vessels following this branch, about the same number as in 1914.

The high line of the fleet was schooner "Rex" of the Davis Brothers fleet, commanded by Capt. Augustus G. Hall. This vessel began fishing about March 1 and completed her season's work November 3. During that time the vessel stocked $30,500, and the crew shared $740. Although some of the vessels of the fleet began fishing earlier in the year and continued later, this stock was not equaled.

The next honors went to schooner "Robert and Richard," Capt. Robert Wharton, of the John Chisholm fleet. This new vessel on her first year's work stocked $29,839, and the crew shared $605.

Others that did well in the halibuting fishery were schooner "Teazer," Capt. Peter Dunsky; schooner "Oriole," Capt. Daniel McDonald; schooner "Cavalier," Capt. Robert B. Porper, and schooner "Monitor," Capt. George Marr.

Schooner "Natalie Hammond," Capt. Charles Colson, that followed the halibuting branch in the summer and the haddocking branch in the winter, also had a fine stock for the year's work. In just a year the vessel stocked $32,970, and the crew shared $772.80. This was one of the best stocks and shares made by any vessel in any branch of the fisheries during the year.

At the beginning of the year 1915 there were but 7 vessels engaged in the halibut fishery, although this number was added to during the middle and toward the last of January.

The first large trips of the year were landed January 27 by schooner "Teazer," Capt. Peter Dunsky, and schooner "Avalon," Capt. Daniel McDonald. The hails were for 30,000 pounds, and the stock of each vessel was in the vicinity of $4,500. Prices during the first part of January were about 16 cents for white and 10 cents for gray.

By the middle of February the fleet had increased to 17 vessels. Prices began to drop about this time, and schooner "Cavalier," Capt. Robert B. Porper, which arrived February 8 with 50,000 pounds, received 11 and 7½ cents per pound.

Schooner "Robert and Richard," Capt. Robert Wharton, arrived February 16, on her maiden trip, with 50,000 pounds of halibut and some hake. The stock on this trip was $5,200, which was the largest made since the previous May, when schooner "Catherine Burke," then commanded by Capt. Daniel McDonald, stocked $5,259.

The first part of March saw heavy receipts of halibut at this port. Three good trips, ranging between 30,000 and 40,000 pounds, were brought here March 4 and 5 by schooners "Kineo," "Monitor" and "Oriole," and three days later the market was flooded with receipts of 150,000 pounds, landed by schooners "Cavalier" "Rhodora," "Avalon" and "Robert and Richard." Schooner "Volant" was in Portland the same day with 20,000 pounds. These trips were all from the eastward and brought prices of 9, 7 and 5 cents per pound.

Heavy receipts continued about the first of April, and the price dropped to 7 and 5 cents per pound.

The first halibuter to arrive with a trip taken on a Magdalene baiting was schooner "Oriole," which discharged her trip here May 25. The vessel was in the ice four weeks, and found fish scarce in the Gulf, so Captain McDonald went to Quero. The vessel had but 10,000 pounds on her arrival here.

Owing to the absence of many of the fleet in the Gulf, receipts of halibut were not heavy during May, and the price rose to 13 and 9 cents per pound.

*Gulf Trips.* — The first big trip from the Gulf was brought by schooner "Teazer," which arrived June 3, hailing for 60,000 pounds of fresh halibut, 35,000 pounds of salt cod and 15,000 pounds of flitches. The prices were 9 and 5 cents for the halibut.

Schooner "Bay State," Capt. Archie McLeod, has the honor of making the largest trip stock of the halibut and shacking fleets. On June 14, from 40,000 pounds of halibut, 80,000 pounds of salt cod, 10,000 pounds of flitches and 40,000 pounds of fresh fish, the vessel stocked $6,315.

There were no unusual trips during July and the market remained rather low.

Schooner "Natalie Hammond," Capt. Charles Colson, on August 18 landed a trip in Boston which set talking all who followed the fisheries. The vessel hailed for 55,000 pounds of fresh halibut, from which the stock was $5,496, and the crew's share $144.50 each. This was the

best stock of the summer, and at that time the third best stock of the year.

Captain Colson was back again in three weeks' time with 35,000 pounds of halibut, which netted a stock of $3,400 and another good share.

The water front had hardly ceased to talk about Captain Colson's great work when the news came, on September 27, that schooner "Rex," Capt. Augustus Hall, had arrived at Portland from Green Bank with a trip that was going to beat them all. The hail was for 55,000 pounds of halibut and the price paid was 11 and 9 cents. The stock was $5,854.72, and the net share for the crew was $153 each.

This was the stock that placed Captain Hall in first place. The stock on the halibut alone was $5,432.77, which was one of the best made in recent years and was second largest stock of the year.

Soon after this time the vessels began either to haul up or shift to haddocking, and receipts of halibut were very light during the remainder of the year. There were but few big trips, and Captain Hall retained his position of high line. He added to his total stock on his last trip on November 3, when he stocked $3,633 and the crew shared $78.

*Salt Bankers.* — A fleet of 9, including the British schooner "Independence II.," sailed salt banking on the spring trip.

The British vessel did not return here until late in the fall, having taken out her spring trip in Lunenburg. Another of the fleet did not return. She was schooner "Senator Gardner," in command of Capt. Reuben Burke, and was burned at sea early in June with 200,000 pounds of fish aboard.

The others of the fleet all had good catches, hailing between 370,000 and 220,000 pounds. The largest trip was that of schooner "J. J. Flaherty," weighing out 359,483 pounds, from which the stock was $12,194.

But four vessels made a second trip. The largest was that of schooner "Athlete," Capt. Thomas Benham, hailing for 300,000 pounds of salt cod, from which the stock was $9,889. Captain Benham was high line of this fleet, with a total stock on two trips of nearly $19,500.

There were 3 in the fleet of dory handliners last year, schooner "Tattler," Capt. Alden Geele; schooner "Governor Russell," Capt. Louis Soares; schooner "Clintonia," Capt. Lew Wharton.

The first vessel led the fleet by a large margin, and Captain Geele brought back one of the largest catches on record, weighing out 478,365 pounds of salt fish for a five months' trip. The stock was $16,534.29. The trip was 10,000 pounds smaller than Captain Geele's record trip of 1909, and the stock $340 less than the stock made by him in 1913, when prices for salt fish were higher than last year.

*Flitches.* — There were but 2 vessels in the flitching fleet, schooner "Atlanta," Capt. Richard Wadding, and schooner "Senator," Capt. Axel Laager. The former vessel landed 110,000 pounds, from which the stock was $9,300.

*Drifters and "Anchor" Fleet.* — Contrary to 1914, the fresh drifters last year did not have an exceptional year. The fares did not reach the size

of the record trips of 1914, and as a result the year's work did not reach the high totals established the preceding year.

The Georgesmen had their usual good year and some excellent trips were brought in. Including the salt drifters, this fleet at the height of the season numbered about 10 vessels.

*Tilefishing.* — In October, schooner "Stranger," Capt. Charles C. Young, under charter of the United States Bureau of Fisheries, sailed on a month's experimental trip for tilefish. Several fares were landed in New York, and through the publicity of the Bureau a demand was created for the fish. At the last of the year there were 3 vessels going to the grounds of Nantucket for this fish, and a number of vessels from New York were also following this branch, and there is every indication that the fleet will be increased as the demand for the fish grows.

*Herring.* — There was a fleet of about 30 local vessels which sailed in the fall of 1915 for the treaty coast of Newfoundland for herring. This was but part of the fleet, however, for several vessels of British registry under local charter brought fares to this port. Owing to the war, there was a heavy demand for herring, and the local dealers were unable to get cargoes enough with their own vessels, and for that reason the British vessels were used. The season at Bay of Islands was a failure, but the fleet managed to get cargoes at Bonne Bay. At the time of writing, the results of the second trip to Newfoundland by several of the fleet are in doubt. Prices by cargo lots were $5.25 for salt bulk, and $5.75 and $6 for barreled herring, believed the highest fare figures on record.

*Nova Scotia and Newfoundland Fares.* — Last year saw the usual heavy receipts of free "green" fish from the Provinces, brought here by the local vessels engaged in freighting as well as by a large number of British schooners.

In May the wholesale fish dealers of this city were greatly stirred when it became known that a duty would be placed on the supposedly "green" fish being brought here from the Provinces owing to a question whether the fish was to be classed as "boned" or otherwise. The question first arose over a shipment of salmon received in Boston from Canada.

The first cargo to arrive from the Provinces while the question was being taken up by the Treasury Department was brought here June 10 by the British schooner "Edith F. S." She had 250,000 pounds of salt fish for Cunningham & Thompson Company.

The discharge of the cargo was not held up, but the consignees were obliged to give a bond double the amount of duty which would be paid if the department ruled that the fish was dutiable. The duty on such fish would be three-quarters of a cent per pound.

Cargoes of this kind continued to arrive, and the consignees in each case were obliged to put up the necessary bond. It is estimated that before the decision was given, on August 11, bonds to the amount of $50,000 had been given over to the local customs authorities.

The decision held that codfish of this kind should not be considered "boned" under the meaning of the law, and therefore not dutiable. The announcement was received with great satisfaction in this city by the wholesalers.

Because the American fisheries are to be prosecuted only by American vessels, Deputy Collector of Customs A. H. McKenzie, June 10, refused to accept the entrance of the British schooner "James R. Clark," which arrived here from the banks, via Yarmouth, N. S., with 55,000 pounds of salt cod, unconsigned to any local fish firm.

Collector McKenzie explained that to all appearances the "Clark" was a British fishing vessel, with her full crew aboard and but recently returned from the banks. Although she entered and cleared at Yarmouth, N. S., this fact was not sufficient, according to the collector, to allow her the designation of a freighting vessel, which class is allowed to enter an American market, provided the cargo is consigned to a party.

The vessel returned to Nova Scotia, where her trip was sold.

*Gill Netters.* — A review of the year would not be complete without a summary of the part taken in the principal industry of this city by the fleet of gill netters and the so-called "Guinea" boats owned by the Italians.

After hauling out of seining in the fall of 1914 the steamers changed to gill netting, and for the remainder of the year operated along the shore and brought in large trips of pollock. Following the pollock run many of the boats discontinued operations until early spring, when the haddock struck in.

The gill-netting branch of the fisheries forms a most important part, as it gives employment not only to the crews of the steamers, but to shore gangs nearly as large as the crews.

The fish brought in here by the steamers are shipped to Boston when the prices are high enough to warrant it; otherwise, the fish are sold to the splitters, whose stock on hand is greatly increased from this source. The year's catch of this fleet, which numbers about 20 or 25 sail, is estimated at 10,000,000 pounds.

*The "Guinea" Fleet.* — Another branch which has grown to great importance in the past few years is the fleet of Italian boats from the fort. These people follow their work in a quiet but most businesslike way, and their operations may seem of but little importance to the public until the results of the year's work are looked at. The fleet numbers about 30 craft, carrying from 3 to 5 men each.

They follow the fresh herring, ground fish and mackerel fisheries in their respective seasons, and the total landing of year run well into millions of pounds.

During the record mackerel run of last year, the little boats made big money. One section of the fort is now entirely owned by people of the Italian colony. They are a hard-working and prosperous people, and of great economic value to the city.

*New Crafts.* — The following summary of shipbuilding operations in the local district for the year of 1915 shows that 11 new fishing schooners have been completed and added to the fleet in addition to a number of gas screw steamers.

Following is a list of the vessels in 1915: —

| | Tonnage. | |
|---|---|---|
| | Gross. | Net. |
| *New.* | | |
| Schooners: — | | |
| Pollyanna, | 120 | – |
| Republic, | 99 | – |
| Catherine, | 159 | 103 |
| Gas screws: — | | |
| Olive, | 22 | 12 |
| Wonasquam, | 18 | 14 |
| Francis Willett, | – | – |
| Wahamo, | 31 | 24 |
| Grace Clinton, | 33 | 18 |
| *Rebuilt.* | | |
| Steamer: — | | |
| Margaret D., | 40 | – |
| Gas screws: — | | |
| Victory, | 21 | 11 |
| Resolute, | 19 | 15 |
| Swan, | 13 | 8 |
| Esther Madeline, houseboat, | 14 | 14 |
| Mao II., | 30 | 18 |
| Prince Olaf, remeasured. | | |

*Vessels Lost and Sold.* — Although several new vessels have been added to the fleet, the loss to Gloucester in vessels sold or lost has been great, and the fleet is at the present time the smallest in the history of the fisheries of this port. Those vessels which were formerly owned here but which have been changed to British registry still continue to come here with cargoes of fish from the Provinces, although they can no longer be classed as Gloucester vessels.

Following is the list of vessels sold the past year: —

*Schooners.*

John R. Bradley, sold foreign.
Monitor, stranded and later floated.
Olga, sold foreign.
Helen G. Wells, sold foreign.
Essex, sold foreign.
Tacoma, sold foreign.
Hattie L. Trask, sold foreign.
Yakima, sold to Florida.
William A. Morse, sold to New London.
Mertis H. Perry, sold foreign.
Fannie A. Smith, sold foreign.
Georgia, sold to Maine.
Pinta, sold foreign.
Monarch, sold foreign.
Grace Otis, sold foreign.
Gossip, sold foreign.

The following gas screw boats have also been sold or lost: —

Ignatius.
Enos.
Ibsen.
Alice.
R. J. Killick.
Venture.
Esther Madeline.
Advance.
George E. Fisher.
Mary L.
Myrtle.
Randolph.
Scout.

The following fishing vessels have been lost this year: —

Ella M. Doughty.
Priscilla Smith.
Aloha.
Senator Gardner.

*Total Fish Receipts for Gloucester.*

*Pounds.*

| | 1915. | 1914. | 1913. |
|---|---|---|---|
| Salt cod, | 10,276,736 | 8,595,300 | 24,628,614 |
| Fresh cod, | 13,834,984 | 15,864,366 | 10,201,544 |
| Halibut, | 2,577,826 | 2,219,607 | 3,658,583 |
| Haddock, | 10,287,453 | 11,910,136 | 6,999,198 |
| Hake, | 5,221,969 | 5,960,968 | 3,997,457 |
| Cusk, | 2,979,625 | 3,129,570 | 2,727,576 |
| Pollock, | 8,925,399 | 9,032,819 | 11,172,558 |
| Flitches, | 268,366 | 332,117 | 505,107 |
| Fresh fish from small boats, | 2,500,000 | – | – |
| Salt fish by rail, | 8,725,842 | – | – |
| Miscellaneous (unclassified), | 500,000 | – | – |
| Not product of American fisheries, | 13,054,412 | 13,661,310 | – |

*Barrels.*

| | | | |
|---|---|---|---|
| Fresh mackerel, | 12,409 | 3,184 | 2,405 |
| Salt mackerel, | 16,609 | 13,895 | 4,846 |
| Fresh herring, | 10,923 | 4,898 | – |
| Fresh bluebacks, | 6,202 | – | – |
| Salt herring, | 52,518 | 31,340 | 26,701 |
| Frozen herring (pounds), | 2,190,049 | – | – |
| Cured fish (quintals), | 69,339 | 31,180 | 21,883 |

Total receipts of fish at port of Gloucester for 1915, 111,004,775 pounds.

*Fishing Boats.* — The modern fishing schooner is the knockabout type, *i.e.*, without bowsprit. This insures easier handling of sails, at the same time giving more room for'ard. The boat is usually 70 to 80 feet in length and about 20 feet in beam, carrying 10 dories and a crew of about 15 hands. This type of boat is especially seaworthy and able to weather the most severe storms, owing to its staunch condition and ability to withstand tremendous strains.

The advent of the power boat has revolutionized shore fishing. Expedition rather than cheapness is essential in fishing, and the man who can get his catch to market the quickest and in the best condition receives a reward which more than offsets the extra cost. The gasolene engine, especially in the form of auxiliaries, saves many hours to the fisherman, does away with the uncertainty of sailing, and enables him to accomplish an increased amount of work in the form of a larger catch, in this way ultimately benefiting the consumer. Power boats are of such an advantage to all types of fishing that it is impossible to say that any one type is benefited more than another. It is greatly due to such a means that the lobster, mollusk, line and trap fishing have been improved, and it has made the small otter trawl applicable for flatfish dredging. It scarcely seems possible that the season of 1907 marked the first extensive use of the power boat in the scallop fishery, whereas at the present time the power boat is used in dredging scallops, sea clams and quahaugs. On the larger fishing boats auxiliary engines equipped with winches save the fisherman much hard labor. Well may the fisherman, and for that matter the public, rejoice in the advent of the gasolene engine.

*Deep-sea Fishing.* — The catch of ground fish by the fleet shows an increase, particularly good catches of haddock having been taken. Codfish, however, have been comparatively scarce. In 1915 the fishing fleet comprised about the same number, 330, as in the previous year, of which 167 were sailing vessels, 13 steam otter trawlers, and 150 boats of various kinds. The catch of the Gloucester gill netters amounted to 7,400,000 pounds, compared with a total of 8,500,000 pounds for the previous year. The total catch of fresh mackerel by the fleet amounted to 71,564 barrels, as against 68,582 barrels in the previous season.

*Quantities and Values of Certain Fishery Products landed at Boston and Gloucester, Mass., during the Year 1915.*

| Fish. | Fresh. | | Salted. | | Total. | |
|---|---|---|---|---|---|---|
| | Pounds. | Value. | Pounds. | Value. | Pounds. | Value. |
| Cod: | | | | | | |
| Large (10 pounds and over), | 14,568,534 | $487,904 | 6,679,925 | $241,707 | 21,248,459 | $729,611 |
| Market (under 10 and over 2½ pounds), | 18,154,124 | 384,034 | 3,994,245 | 134,725 | 22,148,369 | 518,759 |
| Scrod (1 to 2½ pounds), | 1,365,466 | 16,914 | 293,603 | 7,676 | 1,659,069 | 24,590 |
| Haddock: | | | | | | |
| Large (over 2½ pounds), | 44,948,106 | 1,131,660 | 130,594 | 2,361 | 45,078,700 | 1,134,021 |
| Scrod (1 to 2½ pounds), | 12,864,944 | 173,792 | - | - | 12,864,944 | 173,792 |
| Hake: | | | | | | |
| Large (6 pounds and over), | 7,769,018 | 157,516 | 300,625 | 5,007 | 8,069,643 | 162,523 |
| Small (under 6 pounds), | 6,820,297 | 119,954 | - | - | 6,820,297 | 119,954 |
| Pollock, | 12,961,313 | 249,188 | 234,640 | 4,070 | 13,195,953 | 253,258 |
| Cusk, | 6,235,801 | 96,003 | 94,943 | 2,347 | 6,330,744 | 98,350 |
| Halibut, | 3,584,175 | 301,787 | 286,510 | 21,509 | 3,870,685 | 323,296 |
| Mackerel: | | | | | | |
| Large (over 2½ pounds), | 695,013 | 67,721 | 1,015,098 | 48,369 | 1,710,111 | 116,090 |
| Medium (1½ to 2½ pounds), | 1,000,525 | 79,512 | 153,296 | 9,999 | 1,153,821 | 89,511 |
| Small (under 1½ pounds), | 5,649,036 | 235,783 | 2,405,434 | 172,695 | 8,054,470 | 408,478 |
| Miscellaneous, | 10,458,913 | 398,865 | 8,931,550 | 186,819 | 19,390,463 | 585,684 |
| Total, | 147,075,265 | $3,900,633 | 24,518,463 | $837,284 | 171,593,728 | $4,737,917 |

## Fishing Fleet of Boston and Gloucester, 1915.

*Number of Vessels.*

| | |
|---|---|
| Bank fishery, | 33 |
| Market fishery, | 102 |
| Mackerel fishery, | 131 |
| Swordfish fishery, | 52 |
| Herring fishery, | 10 |
| Shore fishery, | 82 |
| Total, | 410 |

*Number of Trips.*

| | |
|---|---|
| Boston, | 3,772 |
| Gloucester, | 3,472 |
| Total, | 7,244 |

*Shore Fisheries.*

The returns of the shore, net and pound fisheries have been compiled under section 119, chapter 91, of the Revised Laws. The following table gives the relative abundance of the different species of fish and the statistics of the shore fisheries of Massachusetts for the past eleven years: —

*Statistical Returns of Shore Fishermen.*

| Fish. | 1905. | 1906. | 1907. | 1908. | 1909. | 1910. | 1911. | 1912. | 1913. | 1914. | 1915. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Alewives, | 877,055 | 486,467 | 621,113 | 1,276,132 | 1,207,505 | 1,452,809 | 1,481,860 | 1,076,462 | 594,045 | 653,058 | 312,324 |
| Bluefish, | 31,948 | 42,536 | 11,308 | 30,396 | 50,767 | 25,390 | 95,485 | 29,066 | 17,034 | 17,551 | 12,253 |
| Flounders, | 1,124,196 | 812,398 | 922,534 | 667,928 | 1,181,240 | 1,294,868 | 1,265,901 | 1,375,749 | 181,996 | 1,027,205 | 968,801 |
| Mackerel, | 560,450 | 1,219,021 | 816,915 | 302,109 | 593,263 | 320,066 | 738,558 | 1,064,806 | 727,468 | 1,295,320 | 1,341,021 |
| Menhaden, | 152,080 | 19,425 | 3,525 | 300 | 18,340 | 277,087 | 334,216 | 264,740 | 5,301 | 133,403 | - |
| Pollock, | 3,570,209 | 1,645,567 | 1,745,313 | 774,702 | 797,281 | 1,332,572 | 869,079 | 149,885 | 151,866 | 285,899 | 132,825 |
| Salmon, | 1,240 | 144 | 15 | 23 | - | - | 9 | 9 | - | - | - |
| Scup, | 710,595 | 257,383 | 420,043 | 314,188 | 99,290 | 215,816 | 121,380 | 156,633 | 166,170 | 111,069 | 134,058 |
| Sea bass, | 8,950 | 20,095 | 14,725 | 12,827 | 81,751 | 5,557 | 20,286 | 56,530 | 253,864 | 11,197 | 61,295 |
| Sea herring, | 1,951,201 | 3,075,520 | 2,167,683 | 2,619,451 | 2,944,755 | 1,394,289 | 3,367,020 | 1,887,272 | 1,879,021 | 1,775,877 | 1,098,455 |
| Shad, | 115,771 | 50,686 | 97,410 | 49,594 | 25,350 | 95,707 | 60,772 | 185,321 | 7,006 | 8,118 | 4,058 |
| Squeteague, | 3,574,635 | 2,027,361 | 2,121,112 | 394,904 | 240,058 | 184,355 | 151,603 | 73,236 | 23,585 | 7,128 | 3,187 |
| Striped bass, | 3,497 | 4,605 | 41,422 | 42 | 1,788 | 304 | 177 | 455 | 822 | 50 | 201 |
| Squid, | 514,021 | 408,555 | 929,290 | 1,873,078 | 2,885,433 | 1,471,775 | 1,384,721 | 1,181,829 | 627,319 | 467,125 | 361,393 |
| Tautog, | 2,857 | 12,564 | 33,600 | 12,298 | 12,786 | 24,368 | 17,376 | 16,396 | 20,109 | 31,893 | 5,773 |
| Other edible fish, | 3,661,301 | 4,770,399 | 3,822,704 | 3,999,400 | 3,053,198 | 3,065,086 | 4,170,323 | 2,207,033 | 1,985,991 | 3,703,524 | 1,630,744 |
| Lobsters, | 639,708 | 730,998 | 1,559,829 | 1,552,685 | 1,989,326 | 1,440,066 | 1,233,120 | 956,540 | 814,595 | 849,299 | 845,396 |
| Total pounds, | 17,525,278 | 15,583,727 | 15,328,291 | 13,880,057 | 15,182,231 | 12,600,115 | 15,011,886 | 10,697,182 | 8,156,252 | 10,377,716 | 6,911,784 |
| Total value, | $337,763 34 | $253,683 44 | $262,127 91 | $166,121 86 | $406,014 80 | $342,466 32 | $364,812 92 | $295,297 70 | $258,044 72 | $300,674 54 | $252,089 08 |
| Number of returns, | - | 136 | 117 | 93 | 103 | 105 | 95 | 96 | 79 | 67 | 61 |
| Number of men, | 774 | 430 | 363 | 309 | 369 | 333 | 319 | 296 | 279 | 256 | 223 |
| Number of boats, | 725 | 372 | 325 | 280 | 319 | 289 | 277 | 275 | 240 | 227 | 207 |
| Value of boats, | $115,274 00 | $69,400 50 | $65,537 00 | $53,328 00 | $68,131 00 | $64,544 00 | $62,230 00 | $67,773 00 | $45,709 00 | $49,904 00 | $51,462 00 |
| Number of traps, | 148 | 115 | 126 | 116 | 119 | 100 | 96 | 135 | 84 | 61 | 53 |
| Value of traps, | $116,425 00 | $110,660 00 | $96,385 00 | $83,200 00 | $80,750 00 | $69,600 00 | $64,375 00 | $65,612 00 | $58,900 00 | $57,500 00 | $33,200 00 |
| Number of nets, | 1,606 | 1,641 | 1,212 | 975 | 1,306 | 1,283 | 1,184 | 1,065 | 816 | 837 | 704 |
| Value of nets, | $19,304 00 | $19,591 50 | $17,209 00 | $16,162 00 | $18,591 00 | $20,794 50 | $16,120 00 | $17,725 00 | $14,567 00 | $14,329 00 | $13,786 00 |

*Coastal Streams.* — The examination of our coastal streams, once famous for their alewife and shad fisheries, has continued. Fishways have been replaced and conditions generally improved for these fisheries. Merely a beginning has been made in the work of re-establishing these fisheries, but in the future extended efforts will soon be made to correct the unfavorable conditions now existing.

*Buzzards Bay.* — The investigation of the fisheries of Buzzards Bay was continued for the third year. The work was necessarily confined, owing to lack of suitable appropriation, to the collection of statistics from a number of fishermen who were given the privilege of establishing fish traps. At the end of the year a report covering the three years' investigation was submitted to the Legislature.

### *Mollusk Fisheries.*

General improvement in the mollusk fisheries has been noted and more extensive efforts have been made in clam and quahaug culture. People are beginning to take greater interest in the question of commercial sea farming, and the time is not far distant when the plans continuously advocated for ten years by this commission — the utilization of the barren areas of tidal water along the coast for shellfish farming — will be realized. Experiments have proved that shellfish may be grown with profit, and that the monetary returns of sea farming, area for area, are correspondingly greater than those of agriculture. It is in the interests of economy that the commission has advocated sea farming, not only as furnishing a commercial enterprise for the fishermen, but also as supplying a revenue to the State.

*Scallop.* — The scallop fishery was not as successful as in past years. Owing to the small quantity of seed the season was poor on Cape Cod, and at Nantucket the production was only about one-half that of 1914.

*Quahaugs.* — The excellent yield of the large bed north of Nantucket still continues, but unfortunately for the fishermen the market price was low.

*Clam.* — More inquiries than ever have been received relative to the leasing of flats for clam and quahaug farming, and many shore towns are taking added interest in the cultivation of these mollusks.

*Shellfish Pollution.* — The sanitary conditions of growth and marketing of pure shellfish are of extreme importance in the development of the shellfish industries of Massachusetts. In 1905 the Commissioners on Fisheries and Game were required to close certain areas of tidal water for such a length of time as the State Board of Health recommended, and prohibit therein the taking of shellfish of all descriptions for food. The waters closed in part or entirely were New Bedford, Boston, Lynn and Salem harbors. Within these proscribed areas shellfish, particularly clams and quahaugs, could not be lawfully taken for food. Owing to certain provisions relative to Boston Harbor, whereby clammers with permits were allowed to take clams for bait, it became practically impossible to enforce the law adequately, and a similar condition, which subsequently was partly if not successfully remedied by recent legislation, prevailed at New Bedford.

The number of arrests for violation of the shellfish pollution laws since 1904 are here tabulated.

*Shellfish.*

| | |
|---|---|
| 1904, | 28 |
| 1905, | 53 |
| 1906, | 49 |
| 1907, | 79 |
| 1908, | 76 |
| 1909, | 77 |
| 1910, | 72 |
| 1911, | 68 |
| 1912, | 28 |
| 1913, | 65 |
| 1914, | 72 |
| 1915, | 78 |

(1) *Boston Harbor.* — The permit system of digging clams for bait for fishing steamers under chapter 285, Acts of 1907, was greatly abused, and whereas a portion of these clams were sold for bait, the remainder were sold as food. It was practically impossible to enforce the law as long as the system of granting bait permits by the Boston board of health was in vogue, since it was necessary for a deputy not only to see the clams dug, but also to keep them constantly in sight until sold as food, —

in most cases a physical impossibility. In 1914 convictions were made possible by the abolition of the permit system, but the rigid enforcement of the law in the interests of the public health has been practically nullified, since the penalties imposed have been too insignificant, defendants merely paying the fines and continuing the illegal taking of clams. In spite of numerous arrests this practice has continued to such an extent as to make it necessary either for the courts to deal more harshly with these offenders, or for the law to be so amended as to include a term of imprisonment as well as a fine. Such actions are taken solely in the interests of the public health, and the tendency to allow violators to escape upon the flimsiest technicality is to be deplored by public-spirited and broad-minded citizens.

The attention of this department has been called by the United States Bureau of Fisheries to the sale of mussels from polluted waters of Boston Harbor. This Bureau has been anxious to introduce the mussel as a valuable food, but the sale of mussels from the polluted areas has, to a large extent, offset their good work in placing this delicious and nutritious food on the Boston market. An investigation of the Italian fish markets in the spring of 1914 showed that several firms for nearly three years had been selling mussels taken from the flats of Boston Harbor to French and Italian customers. At the present time about two bushels per day are retailed at the rate of five cents per quart. Unfortunately, the restrictions placed on the taking of clams under section 113 does not apply to mussels, and it is advisable that some provision be made whereby the sale of polluted mussels may be prohibited, since they are as dangerous to the public health as clams.

(2) *New Bedford Harbor.* — The shellfish problem in New Bedford has been under discussion for a number of years. Existing conditions were first called to the attention of the State Board of Health in 1904, and in 1905 prohibitive measures were placed on the taking of shellfish from the contaminated waters of and adjacent to New Bedford. These restrictions continued through the latter part of 1905 and the whole of the year 1906, after which the law was modified, so that in 1907 the boards of health of New Bedford and Fair-

haven were authorized to grant licenses to take shellfish from the restricted areas for bait only. As in the case of Boston Harbor this concession merely resulted in flagrant abuse.

The number of cases and deaths resulting from typhoid fever between 1899 and 1910, according to the New Bedford board of health, is here given: —

| Year. | Cases reported. | Deaths. |
|---|---|---|
| 1900, | 132 | 22 |
| 1901, | 99 | 19 |
| 1902, | 181 | 24 |
| 1903, | 153 | 28 |
| 1904, | 64 | 12 |
| 1905, | 56 | 4 |
| 1906, | 57 | 7 |
| 1907, | 102 | 10 |
| 1908, | 98 | 20 |
| 1909, | 126 | 20 |

The prevalence of the disease in 1902 and 1903 resulted in an investigation which showed that the consumption of quahaugs taken from the Acushnet River was probably accountable for the large number of cases during these two years, since the families of local fishermen who were using these quahaugs as an article of food comprised the principal sufferers. By a careful study of the figures from 1899 to 1910 it will be noticed that during the period of restrictive measures, up to the granting of licenses for bait, the number of cases and deaths was small as compared with prior and subsequent periods. Twenty-nine investigated cases were found to have eaten quahaugs taken supposedly for no other purpose than for bait. It is interesting to note that the majority of the typhoid cases in 1907, 1908, 1909 and 1910 had names similar to the holders of licenses to take shellfish for bait.

In order to save a valuable industry, and especially to facilitate the transplanting of small "seed" quahaugs to pure waters where in time they would become free from the effects

of pollution, a law was passed (chapter 411, Acts of 1911) providing for a board of shellfish commissioners for the city of New Bedford and the town of Fairhaven, which was authorized to regulate the taking of shellfish from the polluted waters of the Acushnet River and of New Bedford and Fairhaven harbors. In 1912 three inspectors were appointed, two from New Bedford and one from Fairhaven. The quahaugs were transplanted to beds in clean water, principally in Swansea and on Cape Cod. Legislation was sought in 1914 for reimbursement of the city of New Bedford and the town of Fairhaven for the deficit occasioned by this law. Experience has shown that this work cannot be self-supporting, as the State law fixes the fees that may be charged, and the natural law of supply and demand regulates the number of fishermen.

The present method of regulating the fisheries by the two local boards appears theoretically ideal, but several drawbacks are evident, chief among which has been the inefficiency of inspection. There is no absolute method of ascertaining whether the shellfish are distributed to the purifying beds or shipped directly to market. Naturally it is difficult for inspectors, no matter how skillful, to follow these transfers under the present conditions, and there is room for considerable improvement before it can be safely guaranteed that quahaugs are not marketed without being sent to the purifying beds. However, with proper care and rigid enforcement of the law on the part of the local inspectors the joint board should be able to avoid these difficulties.

### *Lobster Fishery.*

The present conditions in the lobster fishery are far from satisfactory, as the short-lobster problem is still in an unsettled state. The fishermen from Rockport to Scituate in the past two years have formed associations, the principal object of which is a mutual agreement that they will return all short and egg-bearing lobsters to the water as soon as caught. On the request of these associations authority has been given to certain members to enforce the laws. In but few instances have these agreements been violated, and the associations are to be commended for the stand they have taken. Reports

from several localities state that the catches are increasing, and good results are enthusiastically anticipated.

Our deputies carefully followed the shipments of lobsters to Boston dealers, with the result that in 1915 over 2,400 undersized lobsters were seized and liberated in the waters of the Commonwealth. The permits which formerly were issued to fishermen to hold the egg-bearing lobsters in confinement have all been revoked. In 1915, 3,468 pounds of egg-bearing lobsters were purchased from the dealers, who received shipments from Maine and Nova Scotia.

| Date. | Fishermen. | Traps. | Number of Lobsters above 10½ Inches. | Egg-bearing Lobsters. | Average Catch per Pot. | Ratio of Egg Lobsters to Total Catch. | Average Ratio of Egg Lobsters, Five-year Periods. | Average Catch per Trap, Five-year Periods. |
|---|---|---|---|---|---|---|---|---|
| 1888, . . . | 367 | 21,418 | 1,740,850 | – | 81 | – | | |
| 1889, . . . | 344 | 20,016 | 1,359,645 | 61,832 | 68 | 1: 21.96 | | |
| 1890, . . . | 379 | 19,554 | 1,612,129 | 70,909 | 82 | 1: 22.70 | | |
| 1891, . . . | 327 | 15,448 | 1,292,791 | 49,973 | 84 | 1: 25.80 | 1: 27.06 | 76.0 |
| 1892, . . . | 312 | 14,064 | 1,107,764 | 37,230 | 79 | 1: 29.75 | | |
| 1893, . . . | 371 | 17,012 | 1,149,332 | 32,741 | 62 | 1: 35.10 | | |
| 1894, . . . | 425 | 20,303 | 1,096,834 | 34,897 | 54 | 1: 31.14 | | |
| 1895, . . . | 377 | 17,205 | 956,365 | 34,343 | 56 | 1: 27.80 | | |
| 1896, . . . | 453 | 22,041 | 995,396 | 30,470 | 45 | 1: 32.60 | 1: 33.08 | 49.4 |
| 1897, . . . | 388 | 18,829 | 896,273 | 23,719 | 48 | 1: 37.70 | | |
| 1898, . . . | 340 | 16,195 | 720,413 | 19,931 | 44 | 1: 36.10 | | |
| 1899, . . . | 327 | 15,350 | 644,633 | 16,470 | 42 | 1: 39.10 | | |
| 1900, . . . | 309 | 14,086 | 646,499 | 15,638 | 46 | 1: 41.30 | | |
| 1901, . . . | 331 | 16,286 | 578,383 | 16,353 | 35 | 1: 35.30 | | |
| 1902, . . . | 410 | 20,058 | 670,245 | – | 34 | – | 1: 38.82 | 36.3 |
| 1903, . . . | 300 | 20,121 | 665,466 | – | 33 | – | | |
| 1904, . . . | 326 | 19,539 | 552,290 | 13,950 | 28 | 1: 39.60 | | |
| 1905, . . . | 287 | 13,829 | 426,471 | 9,865 | 31 | 1: 43.20 | | |
| 1906, . . . | 335 | 21,918 | 487,332 | 9,378 | 22 | 1: 52.00 | | |
| 1907, . . . | 379 | 21,342 | 1,039,886[1] | 10,348 | 49 | 1:100.40 | 1: 84.68 | 40.2 |
| 1908, . . . | 349 | 19,294 | 1,035,123[1] | 9,081 | 54 | 1:114.00 | | |
| 1909, . . . | 522 | 29,996 | 1,326,219[1] | 11,656 | 45 | 1:113.80 | | |
| 1910, . . . | 390 | 26,760 | 935,356[1] | 7,857 | 35 | 1: 68.10 | | |
| 1911, . . . | 341 | 19,773 | 822,107[1] | 5,488 | 42 | 1:149.80 | | |
| 1912, . . . | 291 | 16,665 | 631,595[1] | 4,744 | 38 | 1:133.10 | 1:121.14 | 30.8 |
| 1913, . . . | 254 | 13,877 | 543,129[1] | 3,408 | 39 | 1:159.40 | | |
| 1914, . . . | 310 | 16,128 | 566,191[1] | 5,932 | 35 | 1: 95.40 | | |
| 1915, . . . | 253 | 15,042 | 563,598[1] | 5,050 | 37 | 1:111.60 | | |

[1] Number of lobsters above 9 inches.

## The Otter Trawl Fishery.

*Commissioners on Fisheries and Game, State House, Boston, Mass.*

Gentlemen: — I herewith submit a brief report upon the otter trawl fishery of Massachusetts, comprising data obtained from an investigation of steam trawling on Georges in 1912, and from the use of the small otter trawl in Buzzards Bay in 1913.

Respectfully submitted,

David L. Belding, *Biologist.*

*Introduction.* — About 1893, largely as a result of a report upon the "Beam Trawl Fishery of Great Britain," by Capt. J. W. Collins, published by the United States Fish Commission in 1889, beam trawls were first used from sailing boats for catching flounders at Provincetown. At the present time flounder dredging has extended along the south side of Cape Cod, and even as far north as Salem, the power boat largely replacing the sailboat. In 1903 Captain Collins, at that time chairman of this commission, with the co-operation of Capt. L. D. Baker of Wellfleet, made the first demonstration of the use of the otter trawl, which is a more efficient apparatus than the beam trawl. The report of this department in 1904 contains what is probably the first description published in America of the manner of using the otter trawl, and a forecast of its advantages. Since that time two distinct lines of development in otter trawl fishing have taken place: (1) in the large steam otter trawlers which are used for deep-sea fishing; and (2) in the small otter trawl employed in shore fishing.

The largest beam trawler, with a net 150 feet wide, is capable of dragging large areas of deep-sea bottom. This type of fishing aroused much discussion among the commercial fishermen, and restrictive legislation has been demanded under the contention that the fishing grounds were in danger of destruction. In March, 1912, the first investigation of steam trawling ever made in the United States was undertaken by this commission, with a view to determining the extent of the damage to the fisheries at a time when active opposition to steam trawling among the deep-sea fishermen had taken the form of a petition for legislation which would prohibit or restrict this method of fishing. The report of the biologist, which was presented at that time before the congressional committee and incorporated in the Con-

gressional Record, formed the basis of a more complete investigation by the United States Bureau of Fisheries.

The second, the small otter trawl, 35 to 60 feet in width, is of more recent development. Owing to the greater ease in handling, and its better fishing qualities, it has within the last few years rapidly replaced the more cumbersome beam trawl. It is readily adapted for use with auxiliary catboats or power boats, and the greater part of the fishing on the south side of Cape Cod is carried on with these crafts.

The problem of shallow water otter trawling is quite distinct from that of steam trawling, and it is therefore best to study first the question of the deep-sea otter trawl before considering the relation of the small otter trawl to our shore fisheries.

### *Deep-sea Trawling.*

*The Problem.* — The general problem, stripped of all adventitious or local questions, is, broadly stated, how can we best utilize the productive capacity of the coastal waters and of the fishing banks along the North Atlantic coast? Spawning fish must not be destroyed by trawling, or by floating traps which take migratory fish just before they reach their spawning ground, or even by traps and set nets which take shad, bass, sturgeon, alewives and smelt near the mouths of rivers. An actual decrease is already obvious in certain marine species which are restricted in distribution and which return periodically in particular places, *e.g.*, shad, salmon, striped bass, smelt; and in those species which travel along rather definite paths of migration, *e.g.*, scup, mackerel and bluefish. For this reason any method of fishing which takes more than the annual increment of fish and seriously injures the spawning of any species should be eliminated.

*Hand Lining.* — Hand lining catches the largest individuals and does not destroy many immature fish, — a good economic practice, while the cost of equipment is at a minimum. The actual cost, however, has increased with the difficulty of procuring bait. Pollution of shores and streams, together with excessive seining and torching, has destroyed or driven away large numbers of bait fish, such as young menhaden, squid, alewives, herring, *et al.* Ultimately the procuring of bait will be a serious problem for the fishermen. Hand lining is thoroughly American in the sense that it comes nearest to giving equal opportunities

to all, and under natural conditions is adequate for furnishing a reasonable supply of food.

*Net Fishing.* — Increased population and correspondingly greater market demands bring up again the old problem of hand labor *versus* machine. The best-known machinery of the fisheries are the nets of various sizes, materials and types, the efficiency and necessity of which have long since been acknowledged, and which in ordinary and proper use no longer attract attention. The otter trawl, however, is a new type of net devised for operating in those localities which have hitherto been unsubjected to net fishing, viz., the bottom of the sea at a considerable distance from the shore. Essentially it is a large, open-mouthed net dragged for miles by a steam vessel over the bottom of the ocean, and for that reason is to be classified as one form of net fishing.

*Purpose.* — The general object of this investigation was to ascertain the amount of damage, actual or theoretical, caused by steam trawling. For this purpose one trip to Georges was made with Capt. Ralph Thomas on the steam trawler "Foam." Observations were made particularly in regard to the destructiveness of this method of fishing, and followed these general lines: —

1. The percentage and number of edible fish taken.
2. The percentage and species of nonedible fish taken.
3. The destruction of edible fish too small for market.
4. General destruction of fish by trawling.
5. The extent of sea bottom covered.
6. Damage to the sea bottom.
7. Destruction of fish spawn and food.
8. The driving of fish from the fishing grounds.

*Steam Trawlers.* — Ten years ago the steam trawler "Spray" was built as an experiment. Up to 1912, the time of this investigation, five other steam trawlers of an American type were built at a cost of about $50,000 apiece, and put into commission as follows: —

September, 1910, "Foam."
December, 1910, "Ripple."
March, 1911, "Crest."
January, 1912, "Surf."
January, 1912, "Swell."

The "Foam," typical of all American steam trawlers, is constructed entirely of steel, measuring about 126 feet over all,

with a beam of 22 feet, depth 10 feet, drawing 13 feet, and having a gross tonnage of 244. Two short masts are situated fore and aft, and the forward part is raised in turret style, affording a storage room for rigging, barrels, etc., above the forecastle. In front of the pilot house is an open deck partitioned into "checkers," to hold the fish when dumped from the trawl. Two long and one short "checkers" are on each side of a central hatch which leads into the hold, capable of holding 120,000 pounds of iced fish. In front of this hatch is a hoist for unloading the fish and in its rear is a tank with a capacity of 800 pounds for washing the fish before they are packed into the hold. Directly in front of the pilot house is located the winch for operating the trawl, with two large and two accessory drums, around which the steel cable (seven-eighths of an inch in diameter) of the trawl is wound. The whole machinery is operated by a two-cylinder engine, which is controlled by two attendants by means of clutches during the setting or hauling of the trawl.

The pilot house, constructed entirely of steel, is fitted in the usual manner with compass, wheel, bells, speaking tubes. The large wheel operates directly on the rudder, requiring considerable force to manipulate it. To offset the attraction of the steel house the compass is regulated by magnets. A bridge with iron ladders on each side surrounds all but the rear of the pilot house, underneath which are the furnaces and boilers, while further aft is the engine room with a large 450-horse power triple-expansion engine. Along the bulwarks, one on each side, the trawls are laid when not in use. Fore and aft on each side is a steel framework, equipped with pulleys, to take care of the "doors" and steel cable of the trawl. The stern is occupied by a bin for rope and loose ends, a pulley for holding the cables of the trawl together, a log, and a sounding line station.

The crew consists of a captain, mate, chief and assistant engineer, two firemen, a steward and two crews of six Newfoundlanders, — in all 19 men. Each section is alternately on duty for six hours, thus working twelve hours out of the twenty-four. The captain heads one watch, the mate the other, except in stormy or foggy weather, when the services of both are required. A trip usually lasts four to five days, a little over two of which are consumed in running between Georges and Boston, thus giving two to three days of continuous fishing if the weather permits. Night work is carried on with the aid of electric lights

supplied from a dynamo in the engine room, so that the fishing is practically a continuous process.

*The Trawl.* — The main parts of the trawl are the "wings," one on each side, which serve as "leaders," and the net proper, which leads into a large pocket or bag in which the fish are finally hauled aboard. At the forward end of each "wing" is a wooden "door," about 10 by 3½ feet, shod with steel runners, and strengthened by cross bands of iron. At and from the inside corners of the door pass four short chains to join just above the center into a single chain, to which is attached the steel cable. When not in use the two "doors" of the trawl are hung fore and aft on "gallows" equipped with a pulley for the steel cable.

When extended the trawl has a width of 140 feet, but in action probably is less than 100 feet wide. The top rope is about 25 feet shorter than the bottom, so that the net forms a bow. The bottom rope is about 3 inches in diameter, and without leads. Before the trawl is lowered into the water the top rope of the net is attached to the "doors" by a simple knot. The 3-inch meshes of the "wings" and first part of the net are of single twine, then double and triple until the bag or "cod end" is formed of extremely thick and heavy twine. The latter is fitted with a "clapper," so that fish which are once swept within find it impossible to get out. The bottom has a large opening, closed by a rope in what is known as a "cod end" knot, which can be readily loosened when the trawl is hawled aboard.

*Operating the Trawl.* — In setting the trawl the net is lowered over the side and the rope is attached to both "doors," which are lowered to about 20 fathoms. Then the vessel is started, and if within 4 or 5 points of its course the whole cable is let out. If not headed satisfactorily only 50 fathoms are let out, and the net is first towed around into proper position. The fore and aft cables are joined by pulling in the forward cable to lie in the same pulley as the other. If the trawl has been correctly set, the two strands will separate at an angle, but if the doors are not towing upright, and the trawl is not in proper position, the cables will overlap. The pull on the doors and their resistance to the water at the angle at which they are set cause them to run upright.

The amount of cable let out is approximately three times the depth of the water, but in shallow water a relatively shorter length is used. The trawl is dragged for one and one-half hours, at the average rate of 4 miles an hour, thus sweeping a 6-mile

strip 100 feet in width, a total of 3,168,000 square feet (72.72 acres).

When the trawl is hauled the vessel is stopped, the winches started and the cable is pulled in until the doors are in place. The ropes of the net are then untied from the doors and carried toward each other about mid-deck, where the wings and part of the net are pulled over the sides. Then the large ropes of the net are fastened to the auxiliary drums of the winch, and the net is hauled.

(1) *The Species and Number of Edible Fish.* — This particular trip of the "Foam" resulted in a small catch, in fact, less than half the usual stock. The total number of edible fish taken in 15 hauls of the trawl, out of a total of 35 during the entire trip, was 4,665 (82 per cent. of the total catch of 5,685). Of these, 3,435 (60.4 per cent.) were saved for market, and 1,230 (21.6 per cent.) were thrown overboard. The largest catch, as can be seen from the following table, was in haddock. Of the 21.6 per cent. thrown overboard, 596 (10.47 per cent.) were summer flounders, 617 (10.84 per cent.) small haddock, and 17 (.29 per cent.) undersized cod.

*Edible Fish.*

| Species. | Number. | | Relative Per Cent. | | Total Per Cent. | |
|---|---|---|---|---|---|---|
| | Saved. | Over-board. | Saved. | Over-board. | Saved. | Over-board. |
| Cod, | 119 | 17 | 3.46 | 1.38 | 2.10 | .29 |
| Haddock, | 2,472 | 617 | 71.96 | 50.16 | 43.48 | 10.84 |
| Halibut, | 2 | - | .07 | - | .05 | - |
| Wolf fish, | 3 | - | .11 | - | .07 | - |
| Silver hake, | 1 | - | .04 | - | .02 | - |
| Pollock, | 143 | - | 4.14 | - | 2.45 | - |
| Flounders: | | | | | | |
| Winter, | 695 | - | 20.22 | - | 12.23 | - |
| Summer, | - | 596 | - | 48.46 | - | 10.47 |
| | 3,435 | 1,230 | 100.00 | 100.00 | 60.40 | 21.6 |

*Nonedible Fish.*

| Species. | Number. | Relative Per Cent. | Total Per Cent. |
|---|---|---|---|
| Skate, | 938 | 92.00 | 16.50 |
| Smooth dogfish, | 19 | 1.85 | .35 |
| Sculpin, | 32 | 3.13 | .58 |
| Goosefish, | 25 | 2.43 | .47 |
| Toadfish, | 6 | .59 | .10 |
| | 1,020 | 100.00 | 18.00 |

Steam trawling. Hauling the otter trawl.

Pilot house and fish troughs of a steam trawler.

(2) *Nonedible Fish.* — As can be seen from the above tables the total per cent. of nonedible fish is 18. To all practical purposes the skate formed on this trip the entire catch of the nonedible forms, making 16.5 per cent. of the total catch, or, considered relatively to the total nonedible fish, 92 per cent., the remaining 8 per cent. consisting of dogfish, sculpins, toadfish and goosefish. If weight and bulk instead of numbers were considered the percentage would be still higher. These species, especially the skate, are troublesome to the ordinary trawl fishermen, entailing loss of bait and labor in removing them from the lines. The smooth dogfish is not the species which causes so much damage to the fish and nets, but is a bottom feeder, living on crabs and lobsters. The goose or monk fish, of the family of anglers, probably destroys large quantities of food fish. The sculpin and toadfish are only a nuisance to fishermen. It is possible that the time is not far distant when the American public will utilize the skate and other similar forms as acceptable food fish.

The service of the steam trawlers in exterminating such predaceous fish is problematical. Undoubtedly the fish receive hard usage in being dragged over the bottom in the trawl, and are pierced by the prongs of the forks when pitched overboard, but naturally of a hardy nature the majority of these, possibly at least 75 per cent., survive the treatment. So the argument that steam trawling is a help to the fishery by exterminating these pests is not supported by facts.

(3) *The Destruction of Edible Species too Small for Market.* — No summer flounders are taken by the trawlers for the market, but this species constitutes 10.47 per cent. of the entire catch, or 12.25 per cent. of the edible fish taken. All sizes from 4 to 16 inches are thrown overboard with forks and shovels. The number which survive the rough treatment in the net and the wounds from the fork prongs is entirely a matter of conjecture, possibly 50 per cent.

The small haddock, which comprises most of the remaining waste, constitutes 10.84 per cent. of the total catch, or 12.68 per cent. of the edible fish. The total catch of haddock saved for market, including the scrod, was 2,472, while 617 were thrown overboard, 24.93 per cent. of the haddock catch. The small haddock is a delicate fish, and as no signs of life were evident when these fish were thrown overboard, it is doubtful whether any recover from the net and pitchfork treatment. A small amount of cod, .29 per cent. of the total number of fish, was thrown overboard. The total catch of cod was very light on

this particular trip, only 119, of which 17, or 14.3 per cent., were too small for market. With a more plentiful catch results might be different. No pollock, hake, wolf fish, halibut or winter flounders were thrown overboard. Whether a larger mesh would lessen the destruction of small fish is questionable.

(4) *Destruction of Fish by the Otter Trawl.* — The mortality among the fish thrown overboard is probably about 25 per cent. for skates, 50 per cent. for flatfish and 100 per cent. for small haddock and cod. By more careful though less rapid methods the fish could be sorted with less damage to the discarded species, but where speed is a commercial asset such care will never be taken in this type of fishing.

(5) *The Extent of Sea Bottom covered.* — The average drag is one and one-half hours, covering a distance of 6 miles. The net is 140 feet long, but when in action forms a bow about 100 feet in width. These figures show that an average of 3,168,000 square feet, or 72.72 acres, is covered by each drag. In a six-day trip 35 hauls were made, and by this method of calculating a total territory of 2,545 acres was covered.

(6) *Damage to Sea Bottom.* — The trawl makes a clean sweep, but there is no evidence to show that the net itself does any appreciable damage to the bottom.

(7) *Destruction of Fish Spawn and Food.* — On this trip no fish spawn, with the exception of a few sculpin eggs, were found in the trawl. It can be definitely stated that this method of fishing is not likely to destroy the spawn of cod, haddock and many other species of food fish for the reason that their eggs are "pelagic," floating at the surface of the ocean.

The débris in the trawl chiefly consists of starfish, fish heads (evidently thrown overboard from other vessels), rocks of various sizes, deep-sea scallops, barnacles and the black quahaug (*Cyprina islandica*). *It is possible that dragging the trawl over the bottom may destroy the crustacea, echinoderms and other marine forms upon which cod, haddock and other fish feed, or it may ultimately change the character of the bottom to such a degree as to make it less suitable for supporting a large fish population.*

(8) *Driving the Fish from the Fishing Grounds.* — Whether otter trawling is driving the fish from the fishing grounds is largely a matter of opinion. The noise of the vessel has little influence, as Prof. George H. Parker in a report of the United States Bureau of Fisheries has demonstrated that motor boats have little or no effect upon fish. The direct action of the large trawl is perhaps capable of frightening fish, but the effect

can be scarcely more than transitory. The disturbance of the bottom and the destruction of food, if such there be, possibly might drive the fish to seek other feeding grounds.

It is evident that the public is the chief gainer from improved methods of fishing. The otter trawler can fish day and night, except in the fiercest gales, and there is no loss of time in seeking bait. The catch of the steam trawlers comes to market with more certainty and at a shorter interval, a decided improvement in the sanitary condition of the marketed fish as regards time of catching.

*Conclusions.* — The main problem is the preservation of the marine food supply for future generations. For that reason otter trawling should be thoroughly studied, not merely in respect to the immediate demonstrable effects on certain species of fish, but with a view to determining the possible though remote changes which may result after a period of years. This type of fishing should be kept under careful observation, and restricted to definite areas for the purpose of avoiding the unfavorable conditions which have arisen from the excessive use of otter trawls in the North Sea.

The facts here presented give the observations made upon a single trip, and for that reason final conclusions cannot safely be drawn from such insufficient data. As yet we have made only a beginning in the study of this important and far-reaching problem, which concerns the vital interests of our fisheries. Further investigations should be made in the next few years, and ample appropriations should be made for this important purpose.

*The Small Otter Trawl.*

An investigation of the use of the small otter trawl was carried on in Buzzards Bay in 1913, a gasolene oyster dredger equipped with two otter trawls, 55 to 60 feet in width, being used. When dragging the net, which had a working width of 40 feet, the speed of the boat averaged about 3 miles an hour.

*Trawl.* — The small otter trawl is a long tapering net similar to the large trawl. The bottom line is leaded, and a buoy is attached to the bag end of the net by a line, the length of which is about twice the depth of the water. The buoy is attached so that should the net catch on an obstruction and break apart the severed part might be recovered by taking up the buoy. As the boat forges slowly ahead the buoy is first thrown overboard and then the net is dropped over the side of the vessel, great care being taken to keep the doors from becoming en-

tangled in the tow lines. The latter are laid aft, where they are gradually payed out until the proper length is spent, according to the depth of the water, when they are fastened to a bit in the stern of the boat. The time the trawl is down varies with the condition of the tide and bottom, the average being from thirty to forty-five minutes. The trawl is then hoisted aboard by a winch, the cod end opened and the contents dumped upon the deck.

*Results.* — The varieties of fish obtained in the otter trawl between July 18 and August 13 were mostly prominent residents of Buzzards Bay. The species were: winter flounder, summer flounder, four spotted flounder, sand dab, skate, dogfish, whiting, hake, puffer and sea robin. At no time was a sufficient quantity of these fish taken for marketing. The chief source of revenue for the small otter trawl is derived from the winter flounder, which during the summer months was not found in any abundance in the bay.

Probably numerous fish can avoid being taken by the slow-moving trawl, and the species which inhabit the rocky ledges cannot be taken, since the irregular bottom is unsuited for the manipulation of the net. A finer meshed bag over the free end of the net made practically no difference in the catch, indicating that practically no small fish were taken.

By the use of buoys it was possible to operate the otter trawl suspended at various depths. The results of hauls made at the various heights above the bottom were entirely negative, no fish being taken. However, with a fast-moving boat and larger net it might be possible for certain species to be taken by such a method. The limited observations which were made indicate that this method of suprabottom fishing is impracticable.

It is evident that the winter flounder is in danger of commercial extermination through this method of fishing. The flounder is a migratory fish only in a limited sense, and it can be nearly extirpated in any confined area. Unquestionably the small otter trawl is capable of destroying the flounder fishing in a single locality, and it will be interesting to observe its effect in the next few years upon the abundance of winter flounders in Vineyard Sound and on the south side of Cape Cod. In this respect the small otter trawl may prove to be even as objectionable as the more widely famed deep-sea trawl, and it is earnestly to be hoped that some means of restricting its use in different localities in southern Massachusetts may be devised in order to save the winter flounder at least from partial extermination.

## A Report upon the Clam Fishery.

*Commissioners on Fisheries and Game, State House, Boston, Mass.*

Gentlemen: — I herewith submit the following report upon the natural history and culture of the soft clam (*Mya arenaria*). All investigations herein were made in accordance with the provisions of chapter 93, Resolves of 1905.

Respectfully submitted,
David L. Belding,
*Biologist.*

## INTRODUCTION.

*Object.* — The report on the mollusk fisheries for 1909 presented a survey of the clam flats of Massachusetts, showing their extent, condition, present production and possibility of development under cultural methods. The present paper completes this work by submitting a practical method of increasing the clam production of the Commonwealth. The investigation upon which this report is based was conducted for the following purposes: —

1. To determine the rate of growth.
2. To discover and test methods of clam culture.
3. To check the decline in the natural supply.
4. To utilize unproductive flats.

In order to satisfactorily solve these problems a study was made of the natural history of the clam, first, to obtain information upon its spawning, early life history, structure, growth and habits; and second, to apply this knowledge to the problem of clam culture and the improvement of the industry.

*Purpose of the Work.* — For many years the clammers of our shore towns have dug clams from the abundant natural beds, under the impression that these areas would always yield the same bountiful harvest and that man could never exterminate or even decrease the supply. In the last twenty years it has become evident that even the prolific clam could not withstand continued overfishing, and in certain localities, such as the town of Chatham, the commercial clam fishery has almost passed away. The serious effects of the diminution of the clam supply are more apparent on the southern coast of Massachusetts than on the clam flats north of Boston, which are still in a fair condition. Unless some means of checking the decline in the natural supply is found, many clammers will be thrown out of employment and

the consumer will be unable to purchase clams at a reasonable price. For this reason the matter was brought to the attention of the Legislature in 1905, and a three-year investigation was undertaken, to determine, if possible, suitable methods for improving the clam fishery of the Commonwealth.

A practical method of increasing the natural clam supply has already been presented to the Legislature in a previous report (1909). This report presents in more detail the facts upon which the recommendations were based. The main object has been the preservation of the clam supply, but not the curtailment of the fishery by legislation restricting the catch or methods of fishing. The plan presented in this report has for its object the maintenance of both the fishery and the individual fisherman. Not only will it increase the supply but it will increase also the number of men employed and afford better wages. The investigation for the utilization of the barren flats has been essentially of an experimental nature, paving the way for the more extensive work of reclamation.

*Results.* — The preliminary growth experiments of 1905 show that the solution of the problem lies in the development of clam culture either by individuals or by towns, and that the success of such a movement depends upon the proper transplanting of small clams from the localities of heavy set to the so-called barren areas which are capable of production. Clam farming as a commercial undertaking offers the best solution for the utilization of the barren flats and for checking the diminution in the supply. The Commission on Fisheries and Game believes that the economic solution lies in the granting of private leases of sea bottom to individuals, either by the State or town, for a period of years for the purpose of raising shellfish, *i.e.*, to divide a certain portion of the coastal flats of the State into farms which would supply clams instead of vegetables for the market. This report is designed to give detailed information concerning the development of these clam areas for the town and for the Commonwealth.

*Presentation of the Report.* — The aim of this paper is to present to the general public, more especially to the fishermen, a complete history of the clam, arranged in a practical way, which will call attention to the present conditions of the fishery and how it may be improved by clam culture or sea farming. For completeness and convenience the results of previous investigators have been included.

It is difficult to present adequately a report of this nature so that it will be comprehensible to various classes of readers, such as fishermen, general public and scientists, the members of these classes being unfamiliar with the terms used by each other. To make clear the contents to all involves repetition and renders necessary explanations of subjects which may perhaps appear simple to one class and inexplicable to the other two. For instance, it may appear absurd to the fisherman to describe in detail the implements and method of clamming, which are perhaps wholly unknown to the other class of readers, while, on the other hand, it may have a similar effect on the scientist when some simple, well-known doctrine, clothed in new form, is applied to the clam to give the proper impression to the fisherman and general public. Likewise, for the sake of emphasis, certain fundamental principles are repeated from time to time in the following pages.

Since many phases of the clam's life history have been considered already by other investigators, this report, in addition to covering old ground, deals principally with practical clam culture in Massachusetts. In 1887 appeared the first complete account of the clam fishery by Ingersoll (12), published as part of the Fishing Industries and Fisheries of the United States by the United States Fish Commission and the tenth Census. This paper gave a brief account of the life history of the clam and described the fishery in the different States.

The first article upon the young clam was written by Professor Ryder (9) in 1889, when he described its attachment by the byssus to sand grains before burrowing into the sand. Previous to the scientific papers the only mention outside of Verrill's "Report on the Invertebrata of Vineyard Sound" (10) and Gould (11) was found in historical writings. In 1892 the anatomy of the clam and several other mollusks was described by Kellogg (1) in his monograph upon the "Morphology of the Lamellibranchiata Mollusks," the first of a series upon the clam by the same investigator. His other works, as published by the United States Fish Commission, are "Observations on the Life History of the Common Clam, *Mya arenaria*," 1900 (2); "The Clam Problem and Clam Culture," 1900 (3); "Conditions governing the Existence and Growth of the Soft Clam," 1904 (4), followed by a survey report on the clam fishery in New York State entitled "The Clam and Scallop Industries" (5), published as a New York State museum bulletin. The results of these five reports are summarized in a recent book, "The Shellfish

Industries" (6), in which Professor Kellogg presents an excellent account of the life history, habits and growth of the clam.

In the bulletin of the Agricultural Experimental Station at Kingston, R. I., in 1896, appeared a small pamphlet entitled "The Utilization of Waste Products and Waste Places — Part II., the Clam" (7), by Dr. George W. Field, then biologist at the experimental station, — probably the first publication advocating the cultivation of the clam. In 1897 a few notes on clam culture were appended by H. F. Moore to his report on "Oyster Culture" (8), United States Fish Commission bulletin, 1897. Somewhat later, beginning in 1898, a series of investigations were conducted by Prof. A. D. Mead of the Rhode Island Commission of Inland Fisheries, which covered in an excellent manner the artificial propagation and growth of clams in Rhode Island waters. The results of these investigations were recorded in the reports of the Rhode Island Commission of Inland Fisheries from 1900 to 1904, inclusive, while brief mention of the clam fishery has been made in several annual reports since that time.

In 1906 considerable space was devoted to methods of clam planting in the twenty-ninth report of the Maine fisheries (18). Three reports on the clam have already been issued by the Massachusetts Commission on Fisheries and Game, in 1905, 1906 and 1907, consisting of two preliminary papers and a survey report on the condition of the clam fishery of this Commonwealth.

It is to be regretted that so little attention has been given the excellent reports of Dr. Kellogg and Dr. Mead by the people of Massachusetts. Few copies have been in circulation along the coast, a most unfortunate occurrence, since it has rendered practical results from their work impossible.

Except in cases where the subject is of general knowledge due credit is given to previous investigators for any reprinted matter. No claim for originality is made for the chapter dealing with the anatomy, which is chiefly taken from the standard work of Kellogg (1) and from Stafford (19), "The Clam Fishery of Passamaquoddy Bay," and rearranged by the writer to suit the needs of this report.

*Appropriations.* — Chapter 93, Resolves of 1905, empowered the Commissioners on Fisheries and Game to expend for the purpose of the act the sum of $500 per year for a period of three years. It is obvious that no extended experiments in clam culture could be carried on with this limited amount, which had to cover salaries, traveling expenses, cost of planting the experi-

mental beds, etc. The work was carried on as completely as possible with the means at our disposal by planting hundreds of small experimental beds, mostly 1/1,000 of an acre in size, along the entire coast under varied conditions. This method of work proved far from popular, as the majority of the people along the shore, when they learned that the commission was investigating the propagation of clams, expected that their barren flats would be "seeded" at the expense of the State. Naturally, when only small areas were seeded the people were disappointed, not realizing the utter impossibility of restocking all barren flats, — a proceeding that would have cost many thousands of dollars. They also failed to realize that the experimental work and the small clam beds were the preliminary steps toward the solution of the problem by clam farming.

*Courtesies.* — The writer is especially indebted to Dr. George W. Field for the general direction of the work and for his helpful supervision in the investigation; to Prof. James L. Kellogg of Williams College for preliminary instructions, and to the many persons, both summer residents and clammers along the shore, who have used their influence and time in protecting the experimental beds.

*Assistants.* — The work was carried on during the summers from 1905 to 1908, and the writer was aided by several assistants, to whom he wishes to express his appreciation. During the summer of 1905 Roy L. Buffum of Williams College assisted in putting out the preliminary growth experiments; in 1906 four men, J. R. Stevenson, W. H. Gates, C. B. Coulter of Williams College and C. L. Savery were engaged for part of the summer on the clam problem; in 1907 W. G. Vinal of Harvard University, F. C. Lane of Boston University and J. R. Stevenson completed the cultural experiments. As investigations of a similar nature were being carried on at the same time with the scallop, quahaug and oyster, only part of this time was devoted to the clam. From 1907 records were maintained by the writer for the planted beds, which were all discontinued in 1910. Owing to the difficulty of adequately protecting the beds, the average period of observation was seldom longer than two years.

*Localities.* — Work was conducted along the coast by planting experimental beds in the principal clamming towns. Naturally every town could not be given the same attention, owing to the necessity of concentrating the work. Two main divisions were made, (1) the north shore, or from Plymouth north, and (2)

the south shore, or Cape Cod, Buzzards Bay and the islands of Nantucket and Martha's Vineyard. This division was necessary owing to the different conditions in these two localities, which required different types of work. For this reason in 1906 and 1907 three stations were established, two on the north shore, at Plymouth and Ipswich, and the third on the south shore, at Monomoy Point, Chatham.

On the north shore, general observations were made on the habits and growth of the clam as influenced by the food in the water and other natural conditions. Cultural experiments, particularly at Plymouth and Ipswich, were instituted in regard to the effect of different soils upon growth, and the problem of reclaiming the barren clam flats was undertaken. In addition, a biological survey of the clam flats of the Commonwealth, particularly with regard to the location of the set, was made in 1907.

While the work on the south shore was chiefly conducted at Monomoy Point, a great number of experimental beds, especially in 1905, were located at different places. The work at Monomoy Point was chiefly confined to a study of the early life history and habits, and their practical application to spat collecting. Also a number of growth experiments, designed to bring out points of practical benefit to the planter, were conducted. The work in the two localities was so apportioned that there was little needless repetition, except as rendered necessary by the different conditions.

*Laboratories.* — On the north shore no permanent laboratory was established. At Kingston, through the generosity of Mr. Frank J. Cole, a boathouse served as temporary quarters, while at Ipswich the work, almost exclusively of a non-laboratory nature, was conducted mostly on the flats, with field instruments which could be carried by the investigators. At Monomoy Point a permanent laboratory was located in a shanty near the water, consisting of two rooms, one 13 by 10 feet, the laboratory proper, the other 10 by 10 feet, the living and sleeping room. The laboratory was fitted with tables for microscope work, a stove, pump and sink. Around the walls were placed shelves and closets for instruments and chemicals. The living room was equipped with folding cots. In front of the laboratory was a large porch fronting the water and protected by a canvas covering. On this porch was located the aquaria for holding the young shellfish, which were obtained from a floating raft. The raft, 20 by 10 feet, as described in a previous report on the scallop,

was anchored in the Powder Hole, an enclosed body of salt water connected with the ocean by a narrow opening. This body of water was formerly a spacious harbor, but owing to the shifting nature of the sands at Monomoy Point the entrance had gradually filled, forming practically a landlocked bay. On the west side of the Powder Hole was a fine clam flat of about three acres, which afforded ample opportunity for experimental work in clam culture. The raft was of particular assistance in studying the early life history and in spat collecting, as it afforded facilities for spat boxes and for raising the young clams.

## NATURAL HISTORY.

The life of the common clam (*Mya arenaria*), known in New England as the "soft clam," "soft-shelled clam," "long clam" or "long-necked clam," to distinguish it from the quahaug or hard clam, affords interesting as well as practical information. The descriptive names of "sand gaper," "old maid," "manninose," "sand clam," "squirt clam," "butter fish," "gaper clam," and the Indian name "sickishnog," prove that the habits of this mollusk were observed long ago by our forefathers. Indeed, a study of the natural history of the clam is essential in determining proper methods of culture, for the conservation of the natural supply, and for the development of the clam fishery.

### Distribution.

The clam has a wide distribution in the Pacific and Atlantic oceans, in the New and in the Old World. In America its habitat is principally the Atlantic coast, where it is supplanted in the far north by *Mya truncata*, a closely allied species. It is not a native of the Pacific, having been introduced in 1869 with oysters from the east (Stafford (19)), which indicates that it might be possible to successfully introduce some of the large Pacific shellfish into Massachusetts waters.

Ingersoll (12) writes: —

> In this country the Mya clams are found from South Carolina to the Arctic Ocean, where the seals, walrus, polar bear and Arctic fox feed upon them whenever they have a chance. They are scarce south of Cape Hatteras and most abundant on the New England coast. They occur on the northern coasts of Europe as far south as England and France, on the northeastern coast of Asia, in Japan and in Alaska. It is therefore essentially a northern species, and has the same general distribution as far back as the Pliocene and Miocene ages of geology.

In Massachusetts the clam is found along the entire coast in varying abundance, according to the natural conditions, but the greater part of the marketed supply comes from the Ipswich Bay section (Newburyport to Gloucester). Except in rare instances other localities have not the great natural advantages of the Ipswich Bay region, although they once produced a much greater supply of clams than at the present time. In nearly every instance the flats have shown the effects of overdigging, resulting in a more or less depleted condition.

Exposed beaches with open surf are not inhabited by this mollusk, which takes up its stationary life on the tidal flats of bays, inlets, rivers, or on sheltered beaches between low and high water, rarely leaving its burrow after it attains the size of 1 inch. It is found in various kinds of soil, from rocky gravel to soft mud, but thrives best in a tenacious soil of mud and sand, where it lies at a depth of 3 to 12 inches. In walking over a clam flat, especially a flat with a hard, tenacious soil, the wanderer will be greeted by tiny jets of water squirting into the air to a height of a foot or less, and on closer examination will find the soil perforated by minute holes, which mark the location of the clams. The hole is elliptical in shape, and for $3\frac{1}{6}$-inch clams buried $3\frac{1}{2}$ inches below the surface in a mud flat its dimensions are 0.58 by 0.38 inches. The clam lies at various depths, depending upon the size of the animal and upon the type of soil. In some soils the holes show more distinctly than in others, the moistness of the soil often making the holes inconspicuous, which leads to the popular idea that clams move from one locality to another. At low tide the clam rests in its burrow beneath the soil, with its siphon partly retracted, leaving a hole in the surface of the flat. At high tide the clam extends its siphon above the surface of the soil, drawing in a stream of water through the incurrent tube which is guarded by a row of tentacles, and shooting out the water and waste matter in spurts from the excurrent tube. In this manner the animal feeds upon the microscopic plant forms strained from the water by the gills.

*Clam Areas below Low-water Mark.* — Although the natural habitat of the soft clam is between the tide lines, it thrives beneath low-water mark. Experiments have demonstrated that clams will grow faster when continually covered by water, while the presence of submerged beds as well as numerous beds exposed only at the extremely low running tides of winter has been known for years. In Narragansett Bay and in Katama

Bay, Edgartown, the process of "churning" is used to obtain clams from perpetually submerged flats. Other localities in Massachusetts of similar nature are located on the north side of the Joppa Flats in the Merrimac River, which is exposed only a few times during the low winter tides; certain flats in the Rowley, Ipswich and Essex rivers; and a few points along the south side of Cape Cod and in Buzzards Bay. The clams below low-water mark grow more rapidly than those between the tide lines, since they are never exposed, and have, as a rule, a better circulation of water. It is from these areas that considerable spawn is derived for seeding the tidal flats. The good clamming at Newburyport is largely due to the submerged area on the Joppa Flats, which cannot be depleted by digging. Such territories should be protected from digging as much as possible, as they form a natural means for perpetuating the clam supply.

In spite of our lack of knowledge of their exact limits, the beds below low water are probably not extensive. For the most part the cause is mechanical, the character of the bottom in the deeper waters being unsuited to the growth of the clam. In the localities north of Cape Cod the great height of the tides and the swift tidal currents cause the soil to become more rippled toward low-water mark. Below this line shifting as a rule increases, owing to the force of the current. For the same reason we find no clam area exposed to the wash of the sea, though the flat be far below the tide lines. The absence of clams in the quiet waters suited for oyster growth is not explained by these facts, and can be attributed only to the broad term of habitat.

## Anatomy.

When clamming the average fisherman scarcely realizes that the animal is anything more than an inanimate lump of flesh and shell possessing a market value. But the clam, although unsightly to look upon when turned out of the soil, nevertheless possesses many structures which determine its mode of life and affords an interesting basis for the study of its habits and growth. How many persons know that one of the three "brains" of the clam is in its foot? That the mouth of the clam is the part most deeply imbedded in the sand? Or that the intestine passes through the heart? Still, such peculiarities exist.

The exterior of a clam presents two elongated valves, which enclose a yellowish mass of flesh, protruding at one end in the form of a black, readily retracted tube, the siphon or snout. On

the upper side the two valves are joined together at the hinge line by a cleverly interlocking projection and ligament. Beneath the hinge, on a projecting portion of one valve, is an elastic pad which forces the valves apart, in counter action to the two adductor muscles which, when retracted, bring the shell together. The shell, composed of lime arranged in three layers, varies in thickness, color and shape, according to the soil, age and rate of growth. Owing to the fragile nature of the white shell of the sand clam it is easily broken by the digger. The gravel or stony clam has a much thicker shell, but, owing to its growth against hard substances, it is subject to deformities. Prominent on the exterior of the shell are the umbones, — swellings on each valve which are directed anteriorly and toward the hinge, forming the so-called "beak." Concentric lines caused by any temporary interference in growth are often well marked. It is difficult to accurately determine the annual growth. If the clam is a young specimen the edge of the shell will be covered by a brown, protective cuticle. By cutting the adductor muscles the top valve may be lifted like the cover of a book. On its inner surface is seen the attachment of the two adductor muscles connected by a well-marked line, the pallial line, which is formed by the attachment of the mantle. The posterior end of this line is indented to form the pallial sinus, in which lies the retracted siphon.

On removing the shell we find, closely lining the inside, a thin, semitransparent membrane, the mantle, which encloses the body in a fleshy case. At the edge of the shell the opposite lobes of the mantle unite in a thick yellow band, leaving a small slit at the posterior end through which the foot is extruded. At the opposite end the mantle is modified to form the siphon or "neck," an organ consisting of two tubes of tough contractile muscle fibers, which when contracted appear as a small wrinkled lump covered with a black cuticle, but when expanded attains a length of several inches and extends to the surface of the soil. By means of this tube, with a fringe of delicate tentacles at its tip, the clam obtains its nourishment. Water passes in at the large or lower opening and leaves by the smaller or upper, a continual circulation through the body of the clam being established by means of the lashing of minute, hair-like protoplasmic projections (cilia), whereby food and oxygen are brought to the animal. The functions of the mantle are sensory, protective, respiratory and nutritive. It forms a reservoir for the blood, and secretes

by numerous gland cells a sticky substance which becomes impregnated with lime to form the new shell layers, while the horny cuticle is secreted by cells at its edge.

Beneath the mantle the curtainlike gills, two on each side of the visceral mass, hang free in the mantle chamber for two-thirds of the length of the shell. Dorsally they are united to each other and to the visceral mass, but hang free ventrally, thus dividing the mantle chamber into a larger ventral and a smaller dorsal portion, the branchial and cloacal chambers respectively. The water which has entered the branchial chamber through the incurrent siphon passes through the gills into the cloacal cavity and out by the upper or excurrent siphon. The gills may be roughly compared to sieves, by which the solid particles, including the minute forms on which the clam feeds, are strained from the water.

Between the gills lies an oval white body, the visceral mass, which contains the various organs of digestion and reproduction. At its lower anterior portion is a small muscular foot, the burrowing organ, which, when distended with blood, is extruded from the shell through a slit in the mantle. When not in use this small, spadelike appendage occupies a relatively inconspicuous position, since it is not used as an organ of locomotion after the clam has attained the size of one inch. On each side of this pedal opening are two small ciliated flaps resembling the gills. Their function is unknown, unless they aid in the extrusion of silt and other débris from the mantle chamber.

Within the visceral mass are entwined the folds of the digestive tract, which starts as a funnel-shaped opening just behind the anterior adductor muscle. The mouth is guarded by two pairs of delicate ciliated flaps, the palps, which taper back toward the anterior part of the gills and function in conducting the microscopic food from the gills to the mouth. The œsophagus leads into a stomach, which is surrounded by a dark-colored bilobed gland, the liver, which secretes the digestive juices. The intestine, a slender tube, winds down into the visceral mass in a series of convolutions, and finally passes backward through the central chamber of the heart, ending just above the posterior adductor muscle, in the region of the excurrent siphon. In a fold of the intestine near the stomach lies a translucent gelatinous rod, — the crystalline style which assists the process of digestion. This rod has frequently been considered by the clammers as the young of the eel or some parasite of the clam.

The chief organ of circulation, the heart, consisting of a ventricle and two auricles, is situated just below the hinge line posterior to the stomach. The course of the circulation is through the two aortæ, anterior and posterior, to the various parts of the body, whence the impure blood is sent to the gills, and thence after aeration to the auricles, which open into the ventricle.

The nervous system consists of three pairs of ganglia, little round white organs, about the size of a pin head, connected by fine commissures. They are situated near the mouth, in the visceral mass just below the posterior adductor, and in the foot, all three being in communication with each other by nerve fibers.

The excretory organs, the nephridia, consist of dark-colored tubes of glandular nature lying beneath the pericardial chamber, one on each side of the body. By one end these tubes open into the pericardium, by the other into the mantle chamber at the base of the gills. Their function is essentially the same as the kidneys in higher animals, — the extraction of the waste material from the body.

Before spawning has taken place the visceral mass is largely composed of reproductive organs distended with eggs or spermatozoa. The ovaries in the female and the testes in the male surround the folds of the digestive tract, and when mature give a plump, white appearance to the body of the clam. These organs open by small ducts close to the openings of the excretory system beneath the free border of the inner gill.

### Spawning.

Spawning is accomplished by the discharge of eggs from the female and spermatozoa from the male into the water, where fertilization takes place by their union. With other animals it is often possible to distinguish the male from the female by difference in size or form, but with the clam it can be determined only by examination of the sexual products after the ovaries or testes have been cut open. The sexual cells are extruded from the reproductive organs into the upper mantle chamber, whence they are carried out of the excurrent siphon and passed into the water by successive puffs, similar to the exhaling of smoke.

*The Egg.* — The mature egg when ready for fertilization in the water is a white, spherical body, often enclosed in a gelatinous case, but within the ovary or in masses it has a compressed, irregular form, due to pressure. When viewed under the microscope it has an opaque appearance, owing to the yolk granules

within the protoplasm of the cell. The diameter of the average egg is $\frac{1}{16}$ of a millimeter, or $\frac{1}{387}$ of an inch, and the eggs number approximately 3,000,000 per cubic centimeter. (Fig. 1.)

*The Spermatozoön.* — The spermatozoön or male cell is much smaller than the egg, and is composed roughly of two parts, a body $\frac{1}{16}$ the diameter of the egg and a long, whiplike tail, the motile part. The average size of the head is $\frac{1}{260}$ of a millimeter or $\frac{1}{6600}$ of an inch. The spermatozoön is designed by nature to perform the active duty of finding the egg, which is the stationary form containing the nutriment for the future embryo, and for that reason has lost all surplus material. The spermatozoa number approximately 50,000,000,000 per cubic centimeter.

*The Breeding Season.* — In studying the breeding period observations were made at different localities and dates to determine the ripeness of the spawn, and towings were made with a plankton net of silk bolting cloth to determine the number of larvæ in the water at different times. By making towings for definite distances in one location, as at Monomoy Point, during the entire summer, and by counting the number of larvæ in the towings, as described in previous reports, the limits of the spawning season could be determined. The recording of the appearance of the set likewise served to approximately determine the spawning season. The spawning season of the clam in Massachusetts lasts about three months, usually from the first of June to the last of August. (Fig. 16.)

*Temperature and Spawning.* — The time of spawning varies with the locality. This difference is unquestionably due to temperature, since the season begins later as one passes northward along the Atlantic coast, from warm to cold water. In New Jersey clams are said to spawn during May and early June; in Narragansett Bay they spawn in June; on the south side of Cape Cod in June and July; and north of Boston the greater part of the spawning occurs in July and August. Spawning will not take place until the water has attained a warmth suitable for the development of the young larvæ.

The body temperature of the clam, like all cold-blooded animals, varies with its environment. In 1886 Lombard (20) recorded the temperature of the clam (possibly *Venus mercenaria* not *Mya arenaria*) with a thermo-electric instrument, one pole of which was placed inside of the shell. The temperature was found to be $\frac{1}{4}$ degree F. higher than the water, the experiment showing that a definite production of heat occurred.

Upon the clam flats along the south shore of Cape Cod, where the ova are extruded early in the summer, it is not uncommon to find two distinct sets each year, indicating the possibility of a second spawning season. This phenomenon may be due to the fact that clams do not cast off all of their reproductive products at the same time, and later in the season, when other eggs or spermatozoa have matured, they give forth the remainder. Evidently clams spawn at periods of high temperature of the water, so that the time of spawning for each individual possibly extends over some weeks. Sporadic cases of spawning may occur at any time during the year, but with an unsuitable temperature there is little chance of the embryos developing. The writer has found a scallop (*Pecten irradians*) with orange-colored ovaries distended with ripe eggs in December, and has noticed similar instances of ripe eggs in the giant scallop (*Pecten tenuicostatus*) dredged in March on Georges fishing bank.

*Age and Spawning.* — The clam usually spawns when two years old, although in many cases where the growth is rapid it may become mature in one year (Mead (13)). The rate of growth and the size, rather than the age, determine the maturity of the individual clam. From observations at Monomoy Point it was found that the small clams spawned earlier than the large.

*Flats and Spawning.* — The location of the clam with regard to current, soil and time submerged causes more or less variation in the spawning. Mead (13) has shown that clams near high-water mark spawn before those lower down. In the Essex River on June 1, 1906, clams high up in the thatch had partly finished spawning, while the lower flat clams had hardly begun. Under conditions favorable for rapid growth clams should produce a greater quantity and better quality of spawn than those in poor localities.

*Natural Fertilization.* — In nature the eggs from the female and the spermatozoa from the male clam are shot into the water and left to their fate. Their union depends largely upon chance, since the attraction between the egg and spermatozoön extends over only a short distance, and many of the extruded eggs are never fertilized. This natural waste, combined with the destructive agents which afterward beset the young embryo, shows the need of a vast number of eggs for every adult female; otherwise the propagation of the species could not be maintained. Fertilization is the union of the egg and spermatozoön, whereby the

nuclei of the two cells fuse to form a new individual, which will inherit the characteristics of both parents.

From the time of fertilization the young embryo in its various stages of development is beset with all manner of enemies, especially during its free swimming existence. Climatic changes, such as a sudden rise or fall in the temperature and cold rains, as shown by actual count, diminish the number of larvæ, while winds and tides may wash ashore, polluted water may destroy, all manner of sea animals may consume as food, and, finally, the greater part of the remainder may fall on poor ground, where they soon perish.

*Artificial Fertilization.* — Artificial fertilization has been accomplished by Mead (13) by removing the sexual products and mixing the eggs and spermatozoa in a dish of water. Little success has attended such trials by the writer, as the eggs either failed to develop normally or else never passed beyond the veliger state, — that critical period in the artificial propagation of all lamellibranch mollusks. At the present time there is little hope of raising clams directly from the egg, as more extended experiments with the quahaug and the scallop have shown that, with our present knowledge, the commercial production of young mollusks in this way is impracticable. However, there is little need of artificial hatching as the abundant natural set is capable of furnishing a sufficient amount for planting purposes.

## Embryology.

The embryology of the clam is so similar to that of the quahaug and scallop, which have been more fully described in previous reports, that it is unnecessary to enter into a detailed description of the different stages of development before shell formation. Until the shell is formed it is impossible to tell the young clam larva from the quahaug, scallop and many other species. The egg of the clam, as all lamellibrancha, passes through a series of irregular cell division, starting with the single cell and ending with a mass of cells, the blastula, consisting of an outer layer of small cells surrounding an inner layer of larger cells. In about nine hours the outer cells develop hairlike projections of protoplasm, cilia, and the animal begins to roll and later to revolve through the water. At twelve hours the body elongates into the trochosphere, the animal swimming with a spiral motion by means of the cilia, which are now confined to the anterior end of the body. On the under side of the animal

has developed the primitive mouth, by an invagination of the cells in that region, while on the dorsal side, opposite to the mouth, appears the beginning of the shell gland, which marks the development of a new stage in the life of the animal. During the next twenty-four hours a thin, transparent shell creeps slowly over the animal, until it envelops the soft parts. The shell is formed by a secretion from the shell gland, which becomes calcified at two points, forming the two valves. The structure of the young clam or veliger, as it is now called, can readily be seen through the smooth, homogeneous shell. During the process of shell formation various changes in the anatomy of the young clam have taken place which have given rise to a new period of its existence, the veliger stage, perhaps the most critical and important period of its life.

### The Veliger.

The early veliger is characterized by a transparent shell with a straight hinge line and by a swimming organ, the velum, which is a direct modification of the ciliated end of the trochosphere larvæ, consisting of a circular pad of strong, lashing cilia. The young clam at this period measures from $\frac{1}{300}$ to $\frac{1}{250}$ of an inch in length. These numerous little forms swim through the water, where they are the prey of various forms of sea life. The act of swimming is accomplished by the extension of the velum outside of the shell so that the animal can be propelled in any desired direction by the action of the cilia. When placed in glass dishes the veligers can be seen as white specks whirling through the water. If the dish is tapped with a pencil, or if any sudden jar is given, they at once close their shells and settle to the bottom. In a few moments, if all is quiet, they will cautiously extend the velum and renew their swimming.

The chief characteristics of the early flat-hinged veliger are: (1) the transparent shell with the straight hinge line; (2) the velum or swimming organ; (3) a primitive mouth lined with cilia, leading into a cavity in the center of the body, the stomach, and an abbreviated intestine with posterior anal opening; (4) an inconspicuous mantle; (5) two adductor muscles; (6) retractor muscles for the velum. This form is the common for the scallop, quahaug and clam at this age, and it is only toward the last of the veliger period that the specific characteristics which differentiate each species appear.

*Velum.* — The velum is the swimming organ of the young clam between the sizes of $\frac{1}{250}$ and $\frac{1}{125}$ of an inch. With it the clam can swim in any direction or turn in a rotary direction, either clockwise or anticlockwise. The velum is held in position by three retractors, which are attached near together on the posterior part of the hinge line. Two retractors pass from here to the opposite sides of the velum, and a third to its center. By the action of these muscles it is possible to extend or contract the velum, the function of the middle retractor probably being to draw in the center of the velum, which assumes a concave form when retracted. It is interesting to note that when the velum is fully expanded the whole interior, stomach, liver, intestine, is pulled in a ventral direction, leaving a clear space between the soft parts and the hinge. The velum, equipped with two or more sets of cilia, sometimes appears in two small parts, evidently due to the failure of the central portion to expand with the ends.

The formation of the prodissoconch or late veliger marks the completion of this stage. The first noticeable change is in the shell, which, as it increases in size, assumes a rounded form with prominent umbones. The animal has not yet attained the appearance of the adult clam and shows but a slight tendency toward elongation. The shell is still of the same homogeneous texture, while the valves show an equal curvature, differentiating it from the corresponding stages of the scallop and oyster. With this change in form, in preparation for a new existence, the internal parts readjust themselves by discarding certain organs and developing new ones. The most important change is the degeneration of the velum, which is replaced by the foot as an organ of locomotion. This transformation may be divided into four stages: (1) a large velum and a slight indication of a rudimentary foot on the posterior side of the velum; (2) velum about half its normal size with a half-sized foot developing posteriorly, while two gill bars have formed; (3) a still smaller velum advancing toward the mouth, a two-thirds developed foot taking the former position of the velum, three gill bars; (4) active crawling stage, with a large foot and a well-formed byssal gland, while the velum has disappeared in the region of the palps. (Figs. 3 to 6.)

*Foot.* — The foot, which develops at the same time as the gills posterior to the velum, is characterized by a ciliated tip which aids in locomotion. In Fig. 6 a fine muscular structure

can be made out in the foot, which henceforth is used for both crawling and swimming. At this time the byssal gland is prominent as a cleft projection on the ventral side of the foot, although the byssus does not as yet function. The otocysts or balancing organs were first observed in Fig. 4 and by Fig. 6 they had assumed the form of two concentric circles, one on each side of the foot, one-tenth the height of the shell. Within these circles the several revolving granules could be seen.

*Heart.* — The heart was not observed until Fig. 6, when movements could be definitely ascertained whenever the animal was in the act of crawling.

*Gills.* — The gills, in the form of two coils or filaments lined with lashing cilia, make their appearance with the foot in Fig. 4, before the velum disappears. In Fig. 5, when the velum is but slightly smaller, there are three filaments to the gill. In Fig. 6 the same three filaments show a marked increase in size.

*Muscles.* — In Fig. 4 the posterior adductor appears slightly larger than the anterior, but from this time on they are practically the same size. The retractor muscles of the velum are attached near the posterior adductor.

*Mantle.* — In the veliger stage the mantle is in its simplest form, later becoming ciliated as in the adult, and even extending beyond the edge of the shell. The siphon does not make its appearance until later, although there are indications in Fig. 6 that in that region the mantle is about to undergo a modification.

*Digestive Tract.* — Since the animal needs more nourishment with its increasing size, the digestive tract undergoes changes which permit the digestion of a greater quantity of larger food forms. In the early veliger the mouth and œsophagus consist of a ciliated opening one-quarter the height of the shell, which leads into the stomach. The cilia at the entrance to this canal are long and especially adapted for the capture of food particles. In Fig. 6 the palps can be seen as minute films near the mouth, which has followed the retreating velum from the ventral to the anterior side of the clam. The stomach has also shifted its position, so that the former dorsal exit of the intestine has become more posterior. The stomach, with the diverticuli on each side which form the yellow-green liver, is comparatively large in the veliger stage and becomes relatively smaller with the growth of

the shell. The primitive intestine is a straight tube leading from the stomach to a posterior anal aperture. With the growth of the clam the problem of increased digestive powers is solved by the extension of the tube in a series of coils, and the location of the anal opening dorsal to the posterior adductor muscle.

At the beginning of the veliger stage we have found an animal equipped for leading a free swimming life, as evidenced by its size, shape, lightness of shell and swimming organ. At the end of this period we find the animal prepared for another change. Its free swimming days are over; anatomical changes have taken place which enable it to enter upon a new existence. The ciliated foot with prominent byssal gland has taken the place of the powerful velum. This organ enables the clam first to swim through the water and later to crawl on the bottom among the sand grains or over the seaweed in search of a suitable place for attachment by the byssus. The shell has assumed a form more suited to its new existence, and the animal is now able to enter into the period of youth, Nature having adjusted the various organs for life under a new environment.

*Distribution.* — During the spawning season the water is crowded with the small veliger larvæ, which may be taken with a net of silk bolting cloth. The net is pulled behind a dory at a uniform rate of speed, which permits the water to filter through the fine meshes, leaving the clam larvæ and other floating organisms in the net. The contents are washed into a pail containing about 3 inches of water and the water is given a whirling motion with a small stick, which forces the larvæ, by centripetal action, to the center of the pail, where they can readily be removed with a pipette. In this fashion it is possible to obtain approximately all the larvæ from the towing. By using stated distances, the same period of tide and a uniform method of counting with the Rafter cell, as described on pages 118 and 119 in the "Report upon the Quahaug and Oyster Fisheries" (1912), we were able to follow the spawning during 1906 and 1907 at Monomoy Point. Towings at various depths, obtained by sinking the net with weights, indicate that the larvæ are present even to a depth of from 15 to 20 feet. They are especially abundant near the surface of the water, and only during rains does the number at the depth of 10 feet exceed that at the surface.

In the towings two stages of veligers were taken, the early or true veliger and the late or footed form. The later form swims by means of a ciliated foot which had gradually replaced the velum as a swimming organ. During the growth of this foot the disappearing velum aided in the swimming, so that the animal passed through a period where both functioned in locomotion. A greater proportion of the footed larvæ were found in the towings on rough windy days than in calm weather.

The lamellibranch veligers are not affected by light, as they are not attracted by either a dark or a light background. This fact was demonstrated in the following manner: the veligers were left over night in a small circular dish enclosed in a triangular case, two sides of which were black and one side white. In the morning the larvæ, one-half of which were swimming, were evenly distributed about the dish. The same test was repeated, the light side being turned to the window for an hour, with no change in the grouping of the larvæ.

*Destruction.* — During the veliger or free swimming period, as well as during the first thirty hours previous to the shelled stage, the clam larva passes through its most precarious period, which is only partially ended when it settles to the soil or attaches itself to various objects. It is during the free swimming period that the clam is most openly exposed to the elements and to the natural enemies which beset its path. When the fact is considered that only one out of several million eggs liberated by the adult female clam ever reaches maturity, the extent of the destructive powers of nature becomes strikingly manifest. It is during this critical period that the young must be shielded from their enemies. The active enemies of the larval clam may be enumerated as fish, worms, crustaceans, mollusks, etc., which suck down the larvæ as food, even the mother clam unconsciously devouring her hapless babes. However, the vast destruction is not accounted for by the active enemies but is due rather to adverse physical conditions. Severe weather, storms, sudden changes in the temperature and in the salinity of the water during the spawning season, sewage and other contamination from manufacturing sources bring about the destruction of the floating larvæ.

The effect of cold rains upon the larvæ was observed at Monomoy Point in 1906. During a long cold rain counts were made upon the number of larvæ in a certain amount of water which passed through the plankton net. Before the rain began

the number of larvæ at the surface was 26,900 at 3 P.M. July 31; rain started at 12 A.M. on August 1 and continued steadily for fifteen hours, gradually increasing in severity. The rain was cool, 64 degrees F., which was the temperature of the air at 3 P.M. August 1. At 8 A.M. August 1 a surface towing gave 13,900 larvæ, at 3 P.M. August 1 a surface towing gave 15,000, and at 5 to 10 feet below the surface 15,000. The ratio of footed larvæ to the veligers in the morning towing was 1 to 5, in the afternoon towing 1 to 10, showing a loss in the large footed larvæ. It was noticeable that nauplius larvæ, chiefly young barnacles, were more abundant at 10 feet than at the surface in the afternoon tow, whereas these forms are usually more abundant near the surface. These observations showed that after eight hours of rain the number of surface larvæ had decreased one-half. Another record of a similar nature gave the following figures: before the rain, 30,000; after nine hours, 15,000; after fifteen hours, 3,000. After the rain ceased the number of larvæ gradually increased, until it was the same as at the first count.

It was difficult to tell whether the absence of the larvæ from the water was due to their direct destruction or whether it was the result of their settling to the bottom. Undoubtedly, in either case, many perished as a result of a change in salinity and temperature of the water, or from the mechanical beating of the rain on the surface of the water. The density of the surface water in the enclosed Powder Hole was slightly lowered by nine hours of rain, as the fresh water formed a layer near the surface, while the temperature of the water was lowered but 1 degree, from 70 to 69 degrees, during this period.

Another test of the effect of salinity upon the veliger larvæ was made in the aquarium. One thousand larvæ were put into water of the following densities, made by adding fresh water to the salt: (1) 1.016, (2) 1.012, (3) 1.008. After eight hours: (1) the larvæ were apparently unaffected, except that a few showed slightly reduced ciliary action; (2) a few were dead, about 1 out of 50, while the ciliary action was much reduced in others; (3) a few were dead, about 1 out of 40, and ciliary action was reduced. The veligers were apparently more affected than the footed larvæ. After twenty-four hours: (1) the larvæ were only slightly affected, a few having reduced ciliary action; (2) a few were dead and ciliary action was reduced; (3) several were dead and ciliary action was considerably reduced. A further test was made by suddenly drawing off the salt water

from a watch glass and covering the larvæ therein with fresh water for a few minutes; then the fresh water was replaced by salt water, and after standing fifteen minutes the larvæ were examined. No movement was visible. One hour later two larvæ were swimming, and at the end of twenty hours all had fully recovered.

In raising young clams from the eggs in aquaria, the water after a few days became infested with protozoa. Two kinds were observed in the bodies of the dead veligers, one an elongated paramœcium-like form, $\frac{1}{32}$ of a millimeter in length, the other a small, round, actively motile organism.

## Attachment.

Attachment takes place at the end of the veliger or free swimming stage, the young clam fastening itself to various objects, such as sand grains, shells, eel grass, sea lettuce, Enteromorpha, etc., by a horny thread called the byssus, which is secreted from a gland in the foot. The period of fixation marks an abrupt change in the habits and life of the clam, which has deserted its free swimming existence for an alternate crawling and stationary existence. The structure of the clam now becomes more like that of the adult. The new shell growth is sharply separated from the embryonic shell by the formation of a definite growth line, and its texture and composition differ from the homogeneous structure of the early shell. At first the young clam, as described by Kellogg (2), who has made a most careful study of the clam during this period of its life, has a rounded shape like the quahaug, but as it increases in size it takes on the elongated form of the adult. At this period the excurrent and incurrent siphons are present, the excurrent part having a filmy telescopic attachment which draws in and out with a folding motion, similar to that of the young quahaug, as described in the "Report upon the Quahaug and Oyster Fisheries" in 1912. When a stream of water is shot out, the transparent tube is unfolded and held as a hose to direct the flow. With the growth of the clam it gradually atrophies, until only a slight trace can be found in the adult. The ends of the siphons are equipped with sensory tentacles, but lack the brilliant pigmentation of the older clams.

The most prominent organ of the clam at this age is the relatively large muscular foot, which serves as an organ of locomotion. During the transitional stage from the veliger the foot is

first used as a swimming organ, propelling the animal through the water by a kicking movement. After the clam settles to the bottom the foot is used for crawling. The act of crawling is accomplished with the flexible foot in the same manner as the locomotion of the young quahaug, which is described in full in the "Report on the Quahaug and Oyster Fisheries," 1912, and consists of a forward or following movement, the common method, and a backward movement, which is occasionally employed.

On the under side of the foot is the byssal gland, a conspicuous papilla containing a pore. Numerous cells line this gland and furnish a mucous secretion, which, when coming in contact with water, immediately hardens into a tough, horny thread. When formed the byssus consists of a single translucent thread with several branches tipped with sucking discs for attachment to various objects. Ryder (9) in 1880 found that the young of the soft clam were attached by single branching threads to seaweed and sea lettuce. This fact was clearly demonstrated by Kellogg (2) in his report on the "Life History of the Common Clam," in which he gave excellent drawings of the byssal attachment and proved that the attachment stage was a necessary part of the life of the young *Mya*. The byssus runs from one-quarter to one-half of an inch in length but is so elastic that it can be stretched to a length of $1\frac{1}{2}$ inches without breaking. The clam retains the byssus until it is about three-quarters of an inch, capable of burrowing deeply into the sand. Primarily the function is protection, as it enables the animal, though of small size, to remain in the sand or on the seaweeds, and prevents its being washed from its shallow burrow. Attachment is needed only until the clam attains a sufficient size to protect itself by burrowing. Professor Kellogg (2, 4) showed how the young clams attached themselves in vast numbers to the sea lettuce and Enteromorpha, and later migrated to the mud or sand. In many instances they settle directly upon the soil and attach to the sand grains, large numbers usually settling in limited localities.

### *The Set.*

We have seen in the preceding pages that the young clam, after its free swimming life, either settles upon sea lettuce or Enteromorpha and later migrates to the sand, or that it settles directly upon the sand, attaching by means of the byssus. We will briefly consider a few of the numerous causes influencing

the set and then follow a particularly heavy set of clams from the beginning to the time they become adult clams. For this purpose the set of 1906 on Rowley Reef Knobs in Plum Island Sound has been taken as a typical example.

The time and amount of set varies with the spawning season. The temperature of the water, cold rains and other climatic conditions determine the spawning and set for any year. Since the spawning season lasts from the middle of June to the middle of August, the set may come at any time during July, August or even September, when the requisite conditions are present. Ordinarily the set continues for two or three weeks unless unfavorable conditions intervene. Years of good set may be followed by poor, owing to the condition of the weather during the spawning season. Localities which have a large set one year may have none the next, merely because the conditions which brought about the set have changed. At best, the set is but a happy combination of two factors, — the presence of the larvæ in the water, a fairly constant item, and the variable tide and current conditions of the particular locality. The nature of the soil also plays an important part in deciding whether the young clam can grow after it sets, as slime, silt, soft mud and shifting sand may prove disastrous to its existence.

The set takes place between the tide lines, the ordinary location, and below the low-water mark, in shallow and deep water. The locality is chiefly determined by the relation of the shores to the current or tidal flow, and secondarily depends upon the nature of the soil. There is close similarity in the conditions governing the set of the oyster and the clam, the sandy bars over which the current passes often being the most productive of oyster set.

The relation between these areas, often of extremely thick set, as described by Kellogg (4) and Mead (13), and the regular beds of clams is peculiar. Kellogg distinguished two kinds, the small areas of heavy set and the thin scattering set, and considered the former of little value for the replenishing of the large beds, which were supplied by the scattering clams. This is true as far as it concerns the particular segregations of clams on small areas, these dense sets often resulting in complete extermination. In what way man can take advantage of this fact, and plant many areas of barren flats will be described later. From these densely populated areas ordinarily there is little migration to the large flats, which are replenished by the scattering set, and by clams

from the thatch or sedge banks, which offer excellent places for the spat to catch. Here the small clams, less than $1\frac{1}{2}$ inches in length, unless too strongly imbedded in the roots of the grass, frequently migrate to the flats.

*Current.* — Let us consider the causes which operate to form heavy sets in certain localities and not in others. In what manner is this result brought about and under what conditions do such sets exist? Larvæ have approximately the same abundance everywhere during the spawning season, and it is not absolutely necessary that the spawning clams lie in the immediate vicinity of the set, although the chances of a favorable set are somewhat increased by their proximity. In all probability the actual formation of the set is mechanical in nature. The larva, at the time it is ready for set, has lost its velum and propels itself through the water by a muscular foot. The heavier body has difficulty floating, but is carried in the current in the same manner as suspended silt. When the current becomes slack there is less possibility of keeping afloat, and if perchance the clam larva strikes an object and settles to the bottom it is unable to rise again. On the other hand, if it floats into an eddy or into the quiet edge of a swift current it has a tendency to settle to the bottom. Thus the current acts in a purely mechanical way in distributing the clam set, as if the larvæ were but inanimate objects.

Two conditions appear suitable for a good set, (1) a projecting bar against which the tide sweeps, forming an eddy, and (2) a swift current with slack water along its edge. The first is more commonly recognized by oystermen, and is more nearly in accord with the conditions usually chosen for the capture of oyster spat between the tide lines. In the formation of the Rowley Reef set, as described later, both conditions play an important part.

*The Soil.* — Not every soil is suitable for clam set. In the majority of cases the clam larva falls on poor ground and meets an early death. When the surface is covered with a slimy ooze or has a thick deposit of silt the young clam is soon smothered. Flats filled with tube worms and other enemies of the young larva prove unsuited for the set. Scattering sets have been found on the rippled beaches or on shifting flats, but for heavy sets ripple marks usually denote the limit of their extent. The main consideration in the protection of the set is its shelter from the wave and wind action. Where the flat is so situated that

the wind has a clear sweep no set will be found, since the young clams are either washed away or rolled in windrows upon the beach.

Rocky beaches and gravel bars offer protection for the set by affording places sheltered from wave action where the clam larvæ may settle. Clams cannot exist on shifting beaches, except near large, protecting rocks, but the heavy soil of gravel bars, even when swept by swift tidal currents, renders shifting impossible, so that the young clams having once gained a foothold are lodged as permanent residents.

Sedge and thatch are also natural spat collectors, and if there is any evidence of set it is usually present in such vegetation. Evidently the swimming larvæ strike against the upright plants and fall to the ground, where they find an opportunity to settle in a protected situation. From such a locality they can migrate to the near-by flats, a fact which accounts, in part, for the abundance of clams near thatch islands, as in Barnstable Harbor. In addition, thatch serves as a means of preventing the extermination of the clam, since it protects large numbers of spawning clams from the inroads of the clammers. Many instances are recorded of the thatch bank gradually turning into good clam ground by continued digging. The main point for consideration is the checking of the larval-bearing tidal current in such a way that the larvæ are mechanically deposited. This may be accomplished in other ways than catching in the thatch or on the gravel, such as by the parting of the current either by a projecting rock, by a thatch island or by the branching of the tidal stream, where in the quiet water between the two side currents the set may be found.

*Shore Line.* — Perhaps the best sets are found in little coves where an eddy is formed by an uneven shore. The conditions necessary for an eddy are a fairly strong current and a projecting sand or gravel bar which causes a back flow. In the quiet water thus formed the larvæ are deposited. On Lufkins Flat in Plum Island Sound the set in 1906 was everywhere abundant, except on the outer edge and near the shore, where the flat was strongly rippled by the back current at both flood and ebb tide. The heaviest set took place between the two currents on the level center of the flat. In some instances the eddy exists only until the bar is covered by the tide. Frequently heavy sets are found on the sides of swift currents, as described by Kellogg (4). On the river flats of Plum Island Sound similar sets have been

observed between the tide lines, on the side of a swiftly moving body of water. A possible explanation of this phenomenon is the mechanical settling of the larvæ on the sides of the current where the flow is less swift.

*Notes on the Set of Clams in Various Localities.* — The variations in the spawning season, owing to temperature differences in localities and to the sporadic spawning of individual clams and the variations in the rate of growth, make it possible to find clams of small size every month of the year. Every year sets vary in thickness, *i.e.*, a flat with a heavy set one year may not have any set the next. In the fall of 1906 and in the spring of 1907 the following observations were made on the sets of the flats of Plum Island Sound and Plymouth Harbor.

(1) *Lufkins Flat.* — This flat is situated in Plum Island Sound on the west shore of Plum Island, opposite Ipswich Bluffs. On Nov. 13, 1906, about 2 acres of this flat was covered with a set numbering from 500 to 1,000 per square foot of surface, where a bend in the outgoing tide on the southern edge caused slack water. No 1906 set was present on the rest of the flat. On Nov. 13, 1906, the 1906 set averaged about 11 millimeters in size, and on Aug. 28, 1907, 30.65 millimeters. Clams that had been transplanted from Rowley Reef set to a portion of Lufkins Flat which had no natural set on this latter date, on Nov. 13, 1906, averaged 30.57 millimeters in size, showing practically the same growth.

(2) *Foresides Flat.* — There was a heavy set upon the Foresides, the western part of the Middle Ground in Plum Island Sound, which was not so numerous as Lufkins but covered a larger area. At extreme low tide on the west side the coarse, shifting sand contained a few rapidly growing clams. The area of set lay on a smooth flat of fine sand, between an outer coarse shifting sand and a mud flat near the thatch bank containing larger clams of slow growth. The outer area of Foresides had too swift and unchecked a current, the inner portion too slow a current, for a numerous set, but in the central parts the currents were of sufficient force, yet checked enough by thatch projections and sharp bends to induce an ample set. On Nov. 13, 1906, the set ranged from 2 to 20 millimeters in size. July 1, 1907, the average of the smaller clams gave 20.5 millimeters, or a gain of about 10 millimeters. Clams were still attached to the sand grains by the byssus, and ran from 10 to 50 per square foot. Aug. 28, 1907, in the outer portion the clams averaged

40 millimeters, in the inner portion 29 millimeters, showing the effect of the current on growth. On Aug. 28, 1907, the 1907 set averaged 4.75 millimeters, varying from 2 to 10 millimeters.

(3) *Northeast Sides.* — Upon a small high flat on the northeast side of Plum Island Sound Middle Ground, where the current made a sharp curve, there was a heavy 1906 set upon ground already inhabited by clams of various sizes. In 1907 no set took place.

(4) *Wheelers Flat.* — This flat is situated in the Ipswich part of the Essex River, adjoining the Spit. On July 6, 1907, a set averaging 380 clams per square foot was found over an area of 6 acres, making a total estimate of about 87,500,000 clams. One-half the entire flat, approximating 60 acres, was covered with a scattering set, estimated at 50,000,000 clams, making a total of 137,500,000. The average size was 16.2 millimeters. On the Essex Spit toward the channel, a set running 25 per square foot measured 15.67 millimeters in length. On Aug. 28, 1907, the clams in the thick portion ran about 350 to the square foot and averaged 22.21 millimeters in length.

(5) *Castle Neck.* — Along the west side of Castle Neck in the fall of 1906 was a heavy set of small clams of variable size, averaging 11 millimeters. On Aug. 28, 1907, the clams on the higher portion, where they were submerged but four hours out of the twenty-four, measured 18.65 millimeters, running about 100 per square foot, while low down, with an exposure of only two hours out of the twenty-four, they averaged 36.84 millimeters, at 250 per square foot, and on the outer reef, where they ran 218 per square foot, 29.93 millimeters, showing that the circulation of water and length of time submerged control the growth.

(6) *Greys Flat.* — In Plymouth Harbor in the town of Kingston a set was found on Greys Flat in October, 1906, on the site of the planted clam beds. This set on May 24, 1907, measured 19 millimeters; on Sept. 5, 1907, 26.45 millimeters.

(7) *Coles Shore.* — Along the Kingston shore of Plymouth Harbor was a fair 1906 set, which measured on May 31, 1907, 18.6 millimeters in length.

## Spat Collecting.

The subject of spat collecting in connection with the oyster industry has always received considerable attention. On the other hand, the collection of seed clams has not as yet attained any great importance; but with the development of the industry

**Clam Spat Box.** — This box was suspended from a raft during the summer of 1907. The small clams which were caught in it are heaped before the box. These clams vary in size from ½ to 2 inches in length, showing that the spawning season is at least of two months' duration. The spat box was put down May 15 and taken up October 15. Note the barnacles, silver shells (*Anomia*), etc., on the box and rope.

attempts will doubtless be made to procure large quantities of young clams for planting. There are several ways by which this may be accomplished.

The least probable, yet the most remunerative if successful, is the artificial hatching of clam eggs. While it cannot be definitely stated that this method is impossible, up to this time it has been entirely impracticable, and probably will never be successful from a commercial standpoint. Various investigators have demonstrated that artificial fertilization can be carried out with more or less certainty, but the subsequent rearing of the young larvæ has proved a more serious problem, which is yet to be solved. Mead (13) describes the rearing of a few clams in an aquarium, but no investigator has demonstrated a practicable method whereby a large number can be reared successfully by the culturist. While this problem may appeal to future investigators, its solution is not necessary at the present time, since there are other means of obtaining the young clams in sufficient abundance for planting.

Box spat collectors were first described and used successfully by Mead (14) in Rhode Island, who found that the swimming larvæ could be captured in the water by means of a net of fine bolting cloth. He observed, when the larvæ were in the aquarium, that any sudden agitation of the water, such as would result from a sharp tap on the glass, caused the animals to cease swimming, close their shells and sink to the bottom. In accordance with this fact a spat collecting device, consisting of a square bottomless box with a top of fine galvanized wire screening, was set in the flat so that the sides projected several inches above the sand. As high as 1,300 clams per square foot of sand were taken from this spat collector.

Various spat collectors of this type were tried by this department during 1905 and 1906, with but little success, owing to their precarious location upon flats exposed to strong tidal currents. Boards projecting above the level of the flat proved successful in but one case, the majority soon being undermined by the current. It was observed that this type of collector when covered with copper wire was less successful than with galvanized iron netting. The destructive influence of copper was demonstrated by the death of a small scallop and of clam veligers which were kept in an aquarium in dishes covered with copper wire, and by the survival of others under similar environment when iron wire was used. Galvanized iron netting proved to be

superior to the plain iron, which did not last more than two weeks when exposed to the corrosive action of the salt water.

In the quiet waters of the Powder Hole at Monomoy Point a considerable number of small clams were caught in the boxes of sand without netting suspended at various depths. The heaviest set between 1906 and 1909 was obtained in 1907, ten boxes giving an average of 155 clams, or approximately 100 per square foot of sand surface. The best box gave 200 per square foot. In 1909 the set was poor, as the supply of clams in the vicinity had been almost exterminated. This method of catching the young of various shellfish, while interesting, will hardly become a practical method since the expense far surpasses the returns. At the present time methods of spat collecting are unnecessary as the natural clam set is sufficient to supply abundant seed for planting. By utilizing the heavy natural sets, so abundant in certain localities, which are entirely wasted under natural conditions, the future clam culturist will be able to procure sufficient seed clams. He will obtain his seed by methods such as described for the Rowley Reef set, but as he becomes more adept he will endeavor to let Nature do the work of transportation, turning his grant into a huge spat collector by developing the surface in various ways for catching the set. On examining the sand from the clam flats at Monomoy Point more larvæ were obtained from the hollows than from the surface of the level flat, indicating that an uneven surface is more favorable for collecting the set. The planting of thatch or sedge in rows to catch and hold the set is being tried by Mr. Marcus Howes of Barnstable. Other methods, such as the building of artificial bars to direct the currents so that the set will be deposited upon the grant, should prove entirely practicable.

### The Rowley Reef Set.

In November, 1906, a good illustration of a typically heavy set of clams was found on Rowley Reef Knobs, a sand flat in the form of a horseshoe in Plum Island Sound. Its history and final fate are here recorded.

The set was confined chiefly to the eastern section of a sand bar which was swept by a swift, narrow current except when exposed for three hours at each tide. Upon the west side of this channel a long reef formed the eastern bend of the horseshoe. The area of this set was approximately 3 acres and covered about one-third of the entire flat. The soil was a fine, tenacious

**Rowley Reef Clam Set.** — This photograph shows the surface of Rowley Reef, one of the flats of Plum Island Sound. In the summer of 1906 a heavy set of clams was found on this flat, averaging 1,500 to the square foot of surface. These rapidly diminished, and one year later, Aug. 27, 1907, when this photograph was taken, the clams numbered about 400 to the square foot. This area furnished an excellent illustration of the great destruction of natural clam set. Only 5 per cent. of these clams reached maturity, and the remaining 95 per cent., destroyed by natural agencies, could have been saved if proper measures had been taken. At least 100 acres of the barren flats of Rowley could have been planted with the "seed" from this flat, and after two years the crop would have been worth $30,000. The present shellfish laws of the Commonwealth are alone to blame for this waste. The clam hoe shown in the foreground is the typical digger or "hooker" of the North Shore clammer.

sand, typical of this region, in parts rippled by the current, in others of a firm consistency. The current swept in a curve around the horseshoe at low tide and over it at high, passing in both directions. A projecting salt marsh on Plum Island on the east side of the current caused a partial turn in the current, forming an eddy over the sand flat, and at the same time a spreading of the water on the sides of the channel, both conditions being conducive to a set.

The clammers of Rowley stated that sets frequently occurred on this flat and furnished good digging when the clams had reached maturity. However, such evidence is only hearsay and the prevalence of previous sets is not definitely known. The set was first described in November, 1906, by J. R. Stevenson: —

Upon an area of 600 to 700 feet long, tapering at the ends, and about 150 feet wide in the center, I found a set of young clams from 1,000 to 5,000 per square foot. From an average square foot of sand in which every clam was burrowed out of sight, and in which I counted roughly 1,000 holes, I dug 1,937 clams averaging about one-half inch in length. From a square foot of sand into which the clams had not completely burrowed I sifted 2,416 clams. Roughly estimating this area as containing 50,000 square feet set with clams at least 1,000 per square foot, we have the enormous number of 50,000,000 young clams. These averaged 3,000 per quart, making a total of 17,000 quarts, or over 500 bushels of young clams. Upon the boundaries of this thickly set portion the young clams spread out in decreasing numbers over an extensive area, although few clams could be found in the shifting sand on the top of the reef. This lesser and more scattered set increased perhaps by 50 per cent. the number of young clams upon this reef.

Near the center of the most thickly set area I found a tidal pool, roughly 12 feet long by 6 feet wide and about 15 inches deep. At first sight it seemed but an inch or two in depth, but upon wading into it I sank to my knees. Imagine my surprise when I found that it was not sand into which I sank but a groaning mass of living clams. Here were more than 60 cubic feet of solid clams. Reckoning 2,000 per quart, as these seemed larger than those burrowed in the sand, with 25.7 quarts per cubic foot, I found in this one pool more than 3,000,000 young clams. Upon other portions of the thickly set area were many smaller hollows, set full of clams, layer upon layer, tier upon tier, till the former sand hollows now became ridges of living clams, which could be scooped up by the pailful.

The cause of this enormous set is found in the arrangement of the currents. The main channel of Plum Island Sound takes a bend of 90 degrees just northeast of the reef. Upon the western

side of the channel is slack water. The swift current bearing the larvæ is suddenly checked, and the larvæ as well as sand grains are deposited in the slack water. On the top of the reef and on the western side of the flat the waves beat with too great force to permit of any permanent set, but upon the eastern side of the flat the waves do not exert sufficient power to dislodge the clams, which explains the peculiar outline of the set. When first observed no enemies and no other shellfish, *i.e.*, *Gemma*, *Macoma*, *Mactra*, *Ensis*, *Lunatia*, *Littorina* or *Nassa*, were present. It was a pure set of clams.

*Methods of Transplanting.* — The uneven distribution of set is of importance to the planter; the thicker the set the greater the ease of transplanting. But even with heavy sets the work of obtaining the seed is far from an easy matter. The proper time for collecting is after the clams have reached the size of one-half inch and the byssus no longer holds them firmly to the sand.

For transplanting to experimental beds a sieve was made in the form of a cradle which could be rocked in the water. The framework was covered with fine sand wire, which allowed the sand to sift through, leaving the clams inside. One man rocked this cradle under the water while two others shoveled the sand and clams into the cradle. In this manner the young clams could be obtained for planting entirely free from the soil. On April 25, 1907, three men using the cradle sifter were able to obtain seed clams at the rate of two bushels an hour, or six bushels per tide, since the flat is exposed about three hours. These clams ran about 67,600 per bushel, or a total of 405,600 clams gathered.

From 200 quarts of sand taken from an area of 45 square feet $6\frac{2}{3}$ quarts of clams 15.5 millimeters in size (2,112 per quart) were gathered in six minutes by three men. Hence, three men can dig and sift 2,333 clams per minute, or enough to seed 100 square feet of clam flat. These clams ran about 550 per square foot, but the amount saved by the sifting was only 313 to the square foot. On June 25, 1907, when the clams ran about 450 to the square foot, they could be obtained faster, 166 quarts of sand then yielding 17 quarts of clams, which ran 1,000 to the quart and measured 20.3 millimeters in length. Four men obtained 5 bushels in one hour, or at the rate of $1\frac{1}{4}$ bushels per man, which is considerably faster than two-thirds of a bushel per man obtained on April 25, although the total number of clams was about the same. This successful method of obtain-

ing the seed clams for the experimental beds was used almost exclusively in this section.

Another method of transplanting clams from a locality of heavy set, which was more adapted for commercial purposes and for planting on a large scale, was to load dories with both sand and clams, and, without sifting, to transfer the cargo directly to the place of planting. This method was undoubtedly the best for rapid work or when the planting grounds were near the locality of set. In this way the town of Rowley could have seeded over 100 acres of barren flats at a comparatively slight cost.

A third method of obtaining the seed clams was by digging trenches across the thickly set portion of the flat, thus forming artificial tide pools into which the clams were washed by the waves and could be gathered on the succeeding tide by the pailful. The yield was further increased by turning over part of the surrounding flat with clam hoes. A modification of this method was also used with an incoming tide when a strong wind was blowing. As the tide began to flow, portions of the thickly set flat were turned over in advance of the incoming waters. The waves washed the clams over from the heavier sand and rolled them in windrows where they could readily be gathered. A somewhat slower and more laborious method was to dig the clams under water with a clam hoe, gathering them by hand.

Many bushels of clams were experimentally transplanted to the unproductive flats of Plum Island Sound. The subsequent fate of the clams on Rowley Reef demonstrates how the town of Rowley, by a lack of initiative, allowed thousands of dollars to be wasted merely because, under the present condition of town regulation, satisfactory transplanting could not be carried on by the clammers. Practically the same conditions obtain in many shore towns throughout the Commonwealth.

*Growth of the Rowley Reef Set.* — In most cases areas of heavy set are not always areas of rapid growth, owing to the location and to the greater number of mouths to feed. Rowley Reef set proved an exception to this rule as its rate of growth equaled the average for this section. In the spring and summer of 1908, two years after the set, the first marketable clams were dug as small "steamers," about 2¼ inches in size, the larger specimens being selected. During this period the number of clams had passed through many changes, illustrating the destruction of the natural set. A record of the growth of the set was obtained from

successive examinations, as indicated in the following table. To all practical purposes no growth took place in the winter (not over 2 millimeters), the greater increase occurring in the summer.

| Date. | Size (Millimeters). | Number per Quart. | Number per Bushel. | Number per Square Foot. | Total Number of Clams. | Total Number of Bushels. |
|---|---|---|---|---|---|---|
| Nov. 13, 1906, . . . . | 12.90 | 3,200 | 100,000 | 1,934.0 | 96,700,000 | 967 |
| April 25, 1907, . . . . | 15.50 | 2,112 | 67,000 | 550.0 | 27,500,000 | 411 |
| June 25, 1907, . . . . | 20.30 | 1,000 | 32,000 | 450.0 | 22,500,000 | 703 |
| July 17, 1907, . . . . | 21.20 | 850 | 27,200 | 425.0 | 21,250,000 | 781 |
| Aug. 29, 1907, . . . . | 26.40 | 468 | 15,000 | 400.0 | 20,000,000 | 1,333 |
| May 10, 1908, . . . . | 45.88 | 81 | 2,592 | 53.4 | 2,670,000 | 1,030 |

*The Depletion.* — Nature regulates the number of clams on any flat by the elimination of the weaker or unfit. It is practically impossible for a square foot of soil to contain more than 50 adult clams of the same size, owing to the lack of actual space, even when the hindrances to growth by such crowding are not considered. In any heavy set the majority must perish, the surplus clams being forced out by the pressure exerted by the growth of the others. A cubic foot of soil will hold perhaps 2,000 small clams, but when they have doubled in size it is manifestly impossible for the same space to hold the increased bulk, which results in forcing out the weaker clams or those near the surface of the soil. There are certain exceptions to this rule; for example, at Lufkins, where the soil is hard, the clams cannot be forced out, with the result that the growth is checked. Once out, the clam finds it practically impossible to find space to burrow back into the ground, and must perish unless it can find other favorable ground. It therefore lies on the surface of the flat, and is rolled around at the mercy of the wind and waves, a prey to predatory animals and the warring elements, which soon destroy it; or, if fortune favors, it is carried to suitable ground. In the case of the Rowley Reef the clams that were thrust out of the soil were washed into the deep waters of Plum Island Sound where they perished. The tidal pool mentioned in the first part of the description of Rowley Reef is only one of the many instances where large quantities of clams are washed out of their burrows by the action of wind and tide. Comparatively few reach good ground and restock other flats. As can be seen

from the above table, the ravages of winter are especially heavy upon such unprotected sets.

Not only do the elements destroy these sets but active enemies contribute directly and indirectly to their destruction. Two principal enemies were found on Rowley Reef, but their work was not noticeable until August, 1907, when the clams had attained sufficient size to serve as prey for the cockle or winkle (*Lunatia heros*) and the horseshoe crab (*Limulus polyphemus*), which soon accomplished considerable damage. The horseshoe crabs, in ploughing their way through the sand, displaced from their burrows thousands of clams, which were swept away by the current, and crushed numerous others with their claws, devouring all they could eat. Of eleven horseshoe crabs examined five held crushed clams in their claws, and the stomachs of many crabs examined elsewhere were distended with crushed clams. The cockles did considerably less damage, owing to their slower method of boring through the shell.

*Transplanting of the Rowley Reef Set.* — Several bushels of the small clams were transplanted to the neighboring flats in Plum Island Sound, where the growth was compared with the natural set. Two bushels were sowed upon Lufkins Flat abreast of Ipswich Bluff, just south of the "North Guzzle" and well out upon the flat. Two more were distributed along the west side of Treadwells Island in Ipswich River, in November, 1906, and in the following spring, on April 25, 1907, on North Foresides and Southwest Head in Plum Island Sound. That part of Lufkins Flat where the clams were planted had a slower current than Treadwells and Rowley Reef, and possessed a sort of soft mud and sand. Treadwells was a hard mud flat on the side of a swift current, where rapid growth was obtained for the planted beds. Both places proved suitable for good growth.

| Date. | Rowley Reef. | | Treadwells. | | Lufkins. | | North Foresides. | | Southwest Head. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Size (Millimeters). | Number per Quart. | Size (Millimeters). | Number per Quart. | Size (Millimeters). | Number per Quart. | Size (Millimeters). | Number per Quart. | Size (Millimeters). | Number per Quart. |
| Nov. 13, 1908, . | 12.90 | 3,200 | 12.90 | 3,200 | 12.90 | 3,200.0 | - | - | - | - |
| April 25, 1907, . | 15.50 | 2,112 | 15.75 | 2,018 | 15.74 | 2,018.0 | 15.5 | 2,112 | 15.5 | 2,112 |
| June 25, 1907, . | 20.30 | 1,000 | 19.50 | 1,134 | 17.40 | 1,561.0 | 22.0 | 795 | 20.3 | 1,000 |
| Aug. 29, 1907, . | 26.40 | 468 | 33.20 | 220 | 20.35 | 300.0 | 35.0 | 185 | - | - |
| May 10, 1908, . | 45.88 | 81 | - | - | 45.74 | 81.8 | - | - | - | - |

*Conclusion.* — The fate of heavy natural clam sets, as typified by that at Rowley Reef, indicates that in this respect Nature is destructive and wasteful. Of 2,000 clams to the square foot all but 50 perished, and these were of but slight benefit to the Rowley clammers. Under natural conditions 25 per cent. of these clams were wasted, having perished in the manner previously described. The remedy for such a deplorable condition is arrived at by simply transplanting the clams to unproductive flats before they are destroyed. The potential producing power of the 967 bushels of small clams contained in this flat on Nov. 13, 1906, seems incredible. From some productive flats less than 500 two-year-old clams fill a bushel basket. If it had been possible to successfully transplant this set in its entirety at the end of two years a total of 154,720 bushels would have resulted. Even if half the number had survived the gain would have been enormous, — far greater than in natural areas, where the set is most uneven in its distribution. The value of these clams at 75 cents per bushel would have been in round numbers $110,000 to the town of Rowley, which could at slight expense have transplanted these clams to barren flats and provided profitable clamming for the citizens. The direct cause of this continuous neglect of natural resources is the present state of our shellfish laws, whereby all power is delegated to the town, which can at will either neglect or improve its valuable shellfish resources. Such sets should be unrestrictedly State property, and not improvidently controlled by an individual town.

The presence of such sets as that at Rowley Reef is a great advantage to clam culture, since the necessity for artificial spat collecting no longer exists when nature furnishes such an abundance of seed clams. The planter then merely has to find such places of heavy set and transfer the clams to his grant by any method best adapted to his convenience. In this way these sets, which under natural conditions are wasted and destroyed, may be utilized for the public. The Rowley Reef set is not a solitary instance but is one of many similar sets located in the various coast towns, which afford means of easy and successful planting if proper precautions are observed.

## Enemies.

The numerous enemies of the larval clam have already been described, but even when the young clam has set on good ground, it is not free from enemies, and during this early period

great destruction ensues. We will now consider certain of the more important active enemies of both the young and the adult.

*Waterfowl.* — At various hearings on bills for bird protection before the Legislative committees on fisheries and game during the past few years evidence has been submitted concerning the destruction of shellfish by different species of waterfowl. From facts submitted it was shown that quantities of clams were eaten by coots, shelldrakes and other waterfowl. Although no clams have ever been taken by the writer from the crops of such water birds, other small adult shellfish of a similar nature have been found. If these mollusks are eaten, it is very evident that the small clams which lie near the surface might fall an easy prey to these birds. Dr. Benjamin Sharp once personally described the destruction of small sea clams (*Mactra*) by coots at Nantucket, which indicates that small clams (*Mya*) could be taken as readily by these birds. It is impossible to accurately estimate the extent of destruction from this source.

*Crabs.* — The lady crab (*Ovalipes ocellatus*) is found in abundance on sand flats, where it buries itself up to its eyes and antennæ in the sand and watches for prey or foe, quickly disappearing beneath the surface by burrowing with its "paddles" when danger approaches. The blue crab (*Callinectes sepidus*), which has achieved fame as the edible soft-shelled crab, is less abundant, and usually inhabits muddy shores. This species is larger and more ferocious than the lady crab, and individually may do more damage to clams. The lady crabs greedily devour the small clams, which they dislodge as they scuttle backward into the sand. However, their destructive influence is limited, for in compact flats the clams cannot be turned out in this manner, and only the small are thus captured. On one occasion four clams $1\frac{1}{4}$ inches in length were dropped into a pen containing six lady crabs. One of the latter immediately seized a clam in each large claw and hastened to devour its prey in a solitary corner, but upon pursuit by a companion dropped one in its flight, and finally consumed the remaining clam with the aid of the mandibles, after having broken the valves apart by inserting its claw and crushing the shell. For a while the other clams remained unnoticed, although the crabs passed over them several times, but eventually one was taken, and the captor chased as before. This incident broke the spell, and the remaining clams were then rapidly disposed of.

The horseshoe crab (*Limulus polyphemus*), king crab, or "horse-foot" as it is commonly termed, is found along the Atlantic coast from Maine to Mexico. It inhabits either tidal flats or those just below low-water mark in the summer, being especially abundant during the breeding season, when the eggs are deposited in the sand. The male of this species is considerably smaller than the female. It has a thorax in the form of a horseshoe, bearing two pairs of eyes, and seven pairs of appendages on the under surface; an abdominal portion on the under side of which are several overlapping, platelike appendages; and a long movable spine, which aids the animal in turning. The first pair of thoracic appendages are small and lie in front of the mouth, but like the next four appendages they are tipped with claws which enable the crab to seize, crush and devour young clams. These crabs burrow through a bed of young clams, actually rooting them from the soil, and gorge themselves with the victims. The writer has examined the stomachs of crabs taken from thickly set flats and without exception has found the contents to consist of a mass of crushed clams in various stages of digestion. Considerable damage may be done by a single individual, since the appetite of the crab appears to be insatiable, and culturists should see that their grants are kept free of this voracious enemy.

Another species, the small hermit crab, found so commonly on our beaches, has been observed to devour small clams which were lying exposed on the surface, but damage from this source is of minor importance.

*Fish.* — Although certain fish prey upon young clams, it has yet to be proved that they do any damage to the adults. It is a popular idea among the clammers that the flounder or flatfish takes delight in biting off the tips of the siphons or necks of the clams as it swims over the surface of a flat. If such is true the flounder must necessarily exhibit surprising celerity to catch the sensitive siphon, which is so readily retracted. The writer has never been able to verify this theory by examination of the stomachs of flatfish, nor has he ever found clams thus deprived of the upper portion of their siphons. Such mollusks as *Lævicardium mortoni* and young razor clams (*Ensis directris*) have been found in the stomachs of flounders, and, naturally, small clams before they had burrowed deeply into the flat could be taken in similar fashion by bottom-feeding fish. The species of fish which are destructive to the oyster in southern waters can

do but little damage to the clam, and it may safely be concluded that fish are not a menace to the adult clam but that certain species do destroy the small clam.

*The Oyster Drill.* — Kellogg (2) reports the finding of small clams the shells of which were perforated by the oyster drill (*Urosalpinx cinerea*). However, this pest, so destructive to the oyster, does but little damage to the buried clam, since it cannot burrow far beneath the surface of the flat. Our records indicate that only small clams are attacked and that the perforation occurs at the upper end of the shell in the region of the siphon.

*The Starfish.* — The starfish or "fivefinger" seldom is capable of injuring the clam, which is well protected in its burrow. This animal is the great pest of oyster planters, destroying thousands of bushels of oysters each year. If the clams, like oysters, were exposed on the surface, the starfish would attack them similarly by forcing the valves apart by the slow concentrated action of its sucking feet, and by passing its everted stomach into the shell to digest the contents. Although the damage to adult clams is very slight, the young clam offers a more serious problem. Mead (13) and Kellogg (2) have shown that the young starfish during its development preys particularly on young clams, destroying enormous numbers. Thus in regions where the starfish abounds we have an active enemy capable of doing considerable damage to the clam set.

*The Winkle.* — By far the most destructive enemy of the adult clam is the common winkle or cockle (*Lunatia duplicata* and *L. heros*), which destroys the clam by boring a hole through the shell. In Massachusetts there are three species, *Lunatia heros*, *L. duplicata* and *L. triseriata*, the last possibly erroneously considered to be the young of *L. heros*. *L. heros* is more abundant than *L. duplicata*, the latter being a more southern form, ranging from Massachusetts Bay to the Gulf of Mexico; which, although abundant in Vineyard Sound, rarely occurs on the north side of Cape Cod. *L. heros* is found from Georgia to Labrador, occurs in abundance on the flats in Massachusetts Bay, and has been taken at a depth of 40 fathoms in Vineyard Sound. *L. triseriata*, the small variety, is found in about the same locality. According to Verrill (10) in his "Invertebrates of Vineyard Sound," fossils of both *L. heros* and *L. duplicata* are found in the Miocene, Pliocene and post Pliocene periods.

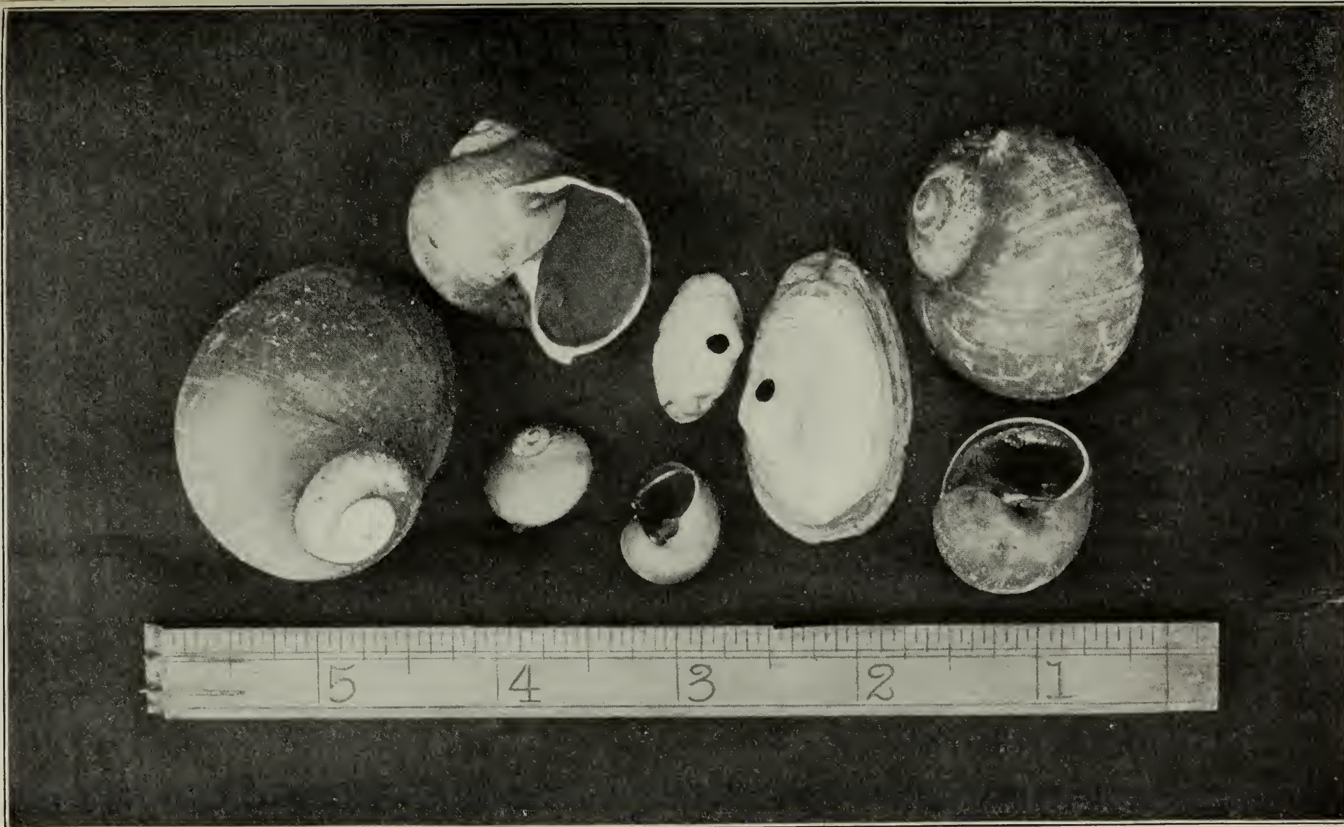
The adult snail inhabits a heavy spiral shell from 2 to 4 inches in length, into which it can withdraw for protection, closing the large aperture by means of a horny operculum attached to its foot. The shell of *L. duplicata* is relatively less high, and the angle at the apex is more obtuse than is that of *L. heros,* its width exceeding its height, while in the region of the umbilicus on the lower side there is a calcareous formation of purple color which is lacking in *L. heros.* The shells of both species are usually of a dull bluish white or grayish color, but old age alters the surface, which becomes rough and worn.

The most noticeable part of the animal's anatomy is the large foot, which is protruded from the shell when the animal is crawling or burrowing. This muscular organ, with thin spreading edges, gives the animal the typical snail appearance with the small shell on the back and the proboscis or feeler in front. A thick mucus is secreted which covers the foot with a slimy exudate, and, according to Verrill (10), assists the sucker-like action of the concave under surface. By means of this foot the animal can burrow in search of clams, sea clams, quahaugs and other mollusks.

On protected harbor flats the usual size of *L. heros* is from 2 to 3 inches, but at Monomoy Point, Chatham, in more exposed waters, they often reach a size of 4 inches.

Of particular interest is the radula or lingual ribbon, which is set with rows of small teeth and enables the animal to drill a clean, countersunk hole, from 1 to 4 millimeters in diameter, through the shell of a clam. With the quahaug, which lives near the surface, the perforation is at the umbones or back in nearly every instance, but in case of the clam the point of attack varies, since the clam, buried upright in the sand, can be reached only by burrowing. To make its attack the cockle envelops the clam with its muscular foot, and after making the perforation with its rasping tongue, sucks out the contents. No mollusks are safe from this potent enemy, and in some cases others of the same species are a prey.

From observations upon lunatia confined in boxes with various sized clams, it was ascertained that the size of the perforation depends upon the size of the lunatia. A $2\frac{1}{2}$-inch lunatia made a $4\frac{1}{2}$-millimeter hole. The experimental clams were placed in boxes forty-eight hours before the lunatia were introduced, in order to give them an opportunity to burrow well into the sand.




**The Winkle or Cockle (Lunatia heros and duplicata).** — An enemy which destroys the clam by boring a hole through the shell and sucking out the contents.

Five sizes of lunatia were used, ½, 1, 1½, 2 and 2½ inches, respectively, while 5 of each of the following sized clams were used: 1, 1½, 2 and 2½, one lunatia being assigned to a box containing 20 clams. The results of two series of four days each are shown in the following table: —

*Table of Clams bored by Lunatia.*

| Lunatia Size (Inch). | Clams. | | | | Total Destroyed. |
|---|---|---|---|---|---|
| | 1 inch. | 1½ inch. | 2 inch. | 2½ inch. | |
| *Experiment I.* | | | | | |
| ½, | - | - | - | - | - |
| 1, | 2 | 1 | - | - | 3 |
| 1½, | 1 | - | - | - | - |
| 2, | 1 | 2 | 2 | 1 | 6 |
| 2½, | 1 | 2 | - | - | 3 |
| Total, | 5 | 5 | 2 | 1 | 13 |
| *Experiment II.* | | | | | |
| ½, | - | - | - | - | - |
| 1, | 2 | 1½ | 1 | - | 4½ |
| 1½, | 1 | 1½ | - | - | - |
| 2, | - | 3 | 3½ | - | 6½ |
| 2½, | 2½ | - | - | - | 2½ |
| Total, | 5½ | 6 | 4½ | - | 15 |

The conclusions from this experiment are as follows: —

1. One-half inch lunatia can do damage to clams over 1 inch in size.

2. One or one and a half inch lunatia cannot operate on clams over 2 inches in length.

3. Two-inch lunatia appear even more effective than the 2½-inch size.

4. Eliminating the ½-inch lunatia with inch clams, 4 lunatia bored 28 clams in eight days, which indicates that 1 lunatia is a potential destroyer of 7 clams in eight days, or about 26 clams per month, if it worked continually. At this rate it would appear that the cockle can satisfy its gastronomical propensities with

approximately 150 small clams in the course of the six summer months. With 2-inch clams, except in one instance, lunatia over 2 inches were alone effective, and performed their work nearly twice as quickly as the smaller cockles.

Another method of determining the respective sizes of lunatia and clams was to ascertain the depths to which various sized lunatia could burrow. The larger a clam the deeper it settles into the sand. In like manner, the burrowing faculties of the lunatia increase proportionately with the size of the animal, but beyond a certain limit it is manifestly impossible for the lunatia to burrow deeply enough to attack the clam. Various sized lunatia were placed in bottomless boxes which were covered with screens and pushed into the sand to depths of 1, 2, 3, 4 and 6 inches, respectively. It was found that lunatia from 1 to $2\frac{1}{8}$ inches in size could burrow under enclosures less than 3 inches deep, but none escaped from those between 3 and 6 inches in depth, indicating that this gasteropod probably does not burrow to a depth of more than 3 inches below the surface.

In spite of the fact that several experimental clam beds were totally destroyed by this enemy, the danger is not to be feared by the culturist, since cockles can be readily gathered for bait at an even greater profit than clams.

During the last few years the industry of gathering cockles for bait, especially for the rip-fishermen, has increased in importance. These mollusks are found most abundantly in places of extensive flats, such as Plymouth, Hingham, Boston Harbor, the Annisquam and Essex rivers, especially in the vicinity of large beds of mussels, sea clams or clams. Formerly they were gathered by hand, but as the supply became scarce they increased in value, and the inhabitants of certain coast towns now make a regular business of catching them with baited traps. This method is practiced in the early spring from the first of March to the middle of May, when the cockles make their appearance on the flats. During the remainder of the season they are picked up by hand. To obtain them on soft mud flats use is sometimes made of a rude board framework, similar in principle to snowshoes, which, by reason of the increased surface, prevents the wearer from sinking into the mud. In this manner the fisherman is able to collect from one to five buckets per day, which he is able to dispose of at the price of 90 cents or more per bucket.

At Hingham the traps are made in the following manner: from the iron tire of a wagon wheel, cut down to make a circle some 30 inches in diameter, is suspended a bowl of 1-inch mesh twine netting. The rim is suspended by three ropes joining some distance above the trap to another rope, which in turn is attached to a floating buoy. To bait the trap some dozen crabs are fastened around the rim by thrusting a stick through the body into the meshes of the net. If crabs are not readily obtainable fish heads are used. One man may easily operate as many as thirty such traps, which require attention but once a day. The average haul is perhaps one-tenth of a bucket to a trap.

Until used the cockles are confined in cars, which usually are made 10 by 6 by $1\frac{1}{2}$ feet, with slats of 2-inch furring, $\frac{1}{2}$ inch apart. During the summer the fishermen call for these cockles once a month or more. In the spring as many as fifty buckets of cockles may be kept without risk in one car, but in the summer, because of the heat, it is not safe to keep more than twenty.

The cockle industry in Massachusetts possesses certain possibilities of development, since the supply of cockles under present methods of fishing will inevitably be exhausted unless some means is found for increasing their numbers. The possibility of rearing the young has as yet not been investigated, but it is hoped that some enterprising fishermen may enter this promising field.

The peculiar egg cases of cockles, in the form of sand collars, which are often seen on flats and beaches, are composed mostly of sand cemented together by a gluelike material. In these collars there are numerous little vestibules containing the eggs. Verrill (10) states that: —

> The peculiar form of these egg masses is due to the fact that they are molded into shape by being pressed against the body of the shell when they are being extruded, and while they are still soft and gelatinous; they thus take the form and spiral curvation of that part of the shell, and when laid in the sand the fine grains at once adhere to and become imbedded in the tenacious mucus, which soon hardens.

The egg case of *L. duplicata* differs from *L. heros* in having a crinkled edge, that of the latter being smooth and plain. A specimen of *L. duplicata* $1\frac{1}{2}$ inches in size was found which had

laid a case $3\frac{3}{8}$ inches in diameter and $1\frac{1}{3}$ inches high. During the spawning season in June and July the cockles apparently enter shallow water to spawn, and deposit their egg cases on the sandy beaches or flats. The practical application of cockle propagation lies in the possibility of collecting the cases, hatching the eggs, and rearing the young in enclosed tidal pools.

The rate of growth invariably depends upon the amount of food consumed rather than upon the age of the cockle. At the present time information with regard to the actual time requisite for the cockle to attain maturity is as yet incomplete. What few observations were made at Monomoy Point in 1906 indicate that growth is rather slow. Various sized cockles confined up to Oct. 22, 1906, in three boxes covered with netting and partly filled with sand, which contained numerous clams for food, gave the following results: —

(A) 40-millimeter lunatia gained 5.75 millimeters in width.
(B) 29-millimeter lunatia gained 3.83 millimeters in width.
(C) 23-millimeter lunatia gained 4.00 millimeters in width.

An average gain in width of 4.53 millimeters ($\frac{1}{4}$ inch) was obtained in two months.

*Worms.* — The question of the actual damage caused by worms is indefinite, and a decisive answer is practically impossible, owing to our inability to secure reliable data. As regards directly injuring the clam, the majority of worms are harmless, but indirectly they interfere with the food supply. However, the conditions which are unfavorable for clams are apparently favorable for worms, thus giving the misleading impression that the worms and not the environment bring about their destruction.

The clam worm (*Nereis virens, N. lumbata, N. pelagica*), occasionally used for bait, is common on mud, sand and gravel flats. Its head is armed with strong, pinching jaws and a large, retractile proboscis, which enables it to prey on various marine forms. The greenish red body is rounded above, flat below, and is divided into separate segments, equipped with projecting tactile parapodia which function as limbs. *Nereis* is often found on flats in close association with clams, a fact which undoubtedly accounts for the name of clam worm. Frequently, clam shells containing the worm are dug up, thus lending credence to the fallacy that the worm destroys clams, but no case has ever been

recorded where a clam was either actually killed or in process of being devoured by this worm. In boxes suspended from a raft at Monomoy Point, in which clams were kept for growth experiments, several young clam worms, not exceeding three inches in length, were found in 1908. Yet all the clams in these boxes were in good condition, which is further evidence that this species is not harmful.

*Glycera americana* is a long, smooth, segmented worm tapering at both extremities, and has a large proboscis armed with four hook-like jaws, similar to those of *Nereis*. It inhabits flats, but is less common and apparently does no damage to clams, since it has been found in experimental boxes with healthy clams.

The presence of numerous tube worms (*Clymenella*) on a flat is usually an indication of an absence of clams, such flats being unfitted for clam growth. This species constructs almost perpendicular tubes of pure sand, which project slightly above the surface of the flat. They can hardly be considered as enemies of the clam, although they may possibly consume the same type of food, and may devour the larval clams. On examination, no diatoms have been found in the stomachs and intestines of these worms. The conditions best suited for this worm are unsatisfactory for clam life, which accounts for the rarity of clams where they are abundant.

The *Meckelia*, recognized by fishermen as the "tape worm," is a large, flat, ribbon-like, flesh-colored worm, usually found in mud or sand flats between tide lines, where it remains a few inches below the surface. Exact measurements are impossible, as the worm is continually expanding and contracting. The adult is from two to three feet in length and about one inch in width. When disturbed it readily breaks into several parts, each of which may regenerate to form a new individual. On one occasion a large specimen when placed upon a laboratory table lay in a sticky mucus, one part of the body seeming to flow to another in a series of wavelike expansions, which enabled the animal to progress slowly. The worm repeatedly thrust out a slender banded proboscis two inches long and one-sixteenth of an inch in diameter, which coiled and uncoiled on the table. When the worm was picked up the proboscis, covered with mucus, shot forward and coiled around the observer's fingers, causing a cool or burning sensation. When placed in formalin by a

forcible ejection it cast off the entire proboscis, which evidently was used as a feeler or sensory organ.

Sometimes this worm occurs in flats where many dead clams are found, and the question naturally arises as to whether it destroys this mollusk. A clam found by Mr. J. R. Stevenson on Grey's Flat, Kingston, with the rim of the mantle and siphon still remaining, contained inside the shell a living tape worm about 4 inches long. Other similar instances have also been observed where it appeared as if the worm had destroyed the clam.

On Jeremy's Point, Wellfleet, a clam was found with a 4-inch *Meckelia* inside the shell. In this case the soft body of the clam was gone, but the mantle, siphon and muscles were still intact and undecayed, showing that it had only recently been killed. The specimen was brought to the laboratory and placed in a small aquarium, when the worm soon crawled out of the shell. During the remainder of its stay of three days in the aquarium it refused to notice the clam, the water finally becoming so foul that it died. Here the evidence points strongly to the fact that the clam was killed by the worm. The fact that the worm did not resume its activities might, however, throw doubt upon a hasty conclusion.

It may be stated conservatively that, although instances may be extant where *Meckelia* have destroyed clams directly, their prevalence on flats unsuited for clams is rather due to natural conditions favorable for their existence but unfavorable to clam life.

*Passive Enemies.* — Certain forms of life injure the clam passively by direct interference with its growth or indirectly by depriving it of necessary food. Mussels and many other species, considered valueless at present, assimilate the same food as the clam, in this way exerting a mildly injurious influence. The mussel beds serve as collectors for clam set, but at the same time destroy many small clams by deposited silt. Diseases are inclined to spread over a flat where the circulation of water is poor, and infected clams quickly contaminate their neighbors.

*Man.* — The influence of man has had severe and far-reaching effects upon the decrease in the clam supply in two ways, either directly in overthrowing the balance of Nature by ill-advised methods of clamming, or indirectly through pollution of waters; but much of the damage may be repaired if man will only assist Nature in its renewal of the supply. By such unwise exploita-

tion it has been reduced to a seriously depleted state. Excessive and ill-advised digging in certain localities has brought the clams to almost complete extinction by the method of taking scattered clams, thus totally depleting acres of flats.

Overdigging is deleterious in its effect in the following ways: (1) adult clams which are capable of furnishing spawn are removed, which naturally leads to a diminution in the reproductive capacity of the bed; (2) actual destruction results from breakage of the shells, and the inability of the injured clam to burrow again in the soil; (3) the number of clams taken from the average flat is greater than its productive capacity, which will result inevitably in a progressive depletion.

With the advent of man upon New England shores came also domestic animals, and we read with interest in Winsor's "History of Boston" that "swine were doubtless instrumental in eradicating clams and mussels at the points they visited, since it is well known that, at localities in the west where they are allowed to run at large, they quickly destroy the fresh-water mussels in all the streams where in seasons of drought they can gain access to these animals."

*Pollution.* — The area of available clam flats has greatly diminished during past years owing to restriction of certain harbors, such as Boston, Lynn and New Bedford, which the State Board of Health, after due investigation, have considered unfit for the production of edible clams. The reason for this action was occasioned by the numerous typhoid epidemics which have been traceable in many instances to shellfish from sewage-polluted waters. The curtailing of this available clam territory is greatly to be deplored, and while protective from the standpoint of the public health, it is by no means a curative measure. The true remedy lies in removal of the causative agents which have produced this condition. Unnecessary pollution of public waters by sewage and manufacturing wastes should be prohibited, and then the present distressing condition of our rivers and streams would be at least ameliorated if not fully remedied. It is our purpose to make an unbiased statement concerning some conditions now existent on clam flats of the State in an endeavor to attract the attention of the public to the necessity of immediate, thorough reform by means of proper legislation. In presenting these facts we wish to specify particularly that the clam industry or clammers of any one section are not the objects of our criticism, but rather the underlying causes which have been

operating during the past century by reason of the laxity of our laws. Many conditions cannot be remedied, but in numerous instances their noxious features may readily be avoided at a comparatively slight expense.

When the first settlers landed upon the "rock-bound coasts" of New England all our streams and tidal waters were unpolluted. As the colony expanded and the various towns arose along the rivers near the ocean, these waters were considered the natural exits for refuse and waste. Towns rapidly enlarged into cities with extensive industrial interests, and the volume of sewage and manufacturing wastes proportionately increased, with little or no effort to prevent such a wanton practice. In this way the fisheries of some of the finest rivers in this Commonwealth, the Merrimac, Connecticut, Taunton, Charles and Mystic, have been ruined. Pollution has not been confined to fresh water alone, but has irretrievably ruined for commercial value shellfish beds in many salt-water rivers and harbors.

The soft clam, unlike the oyster and little-neck or quahaug, is rarely eaten raw, which fact materially lessens the danger of typhoid infection. It feeds in a similar manner to the oyster, acting as a living filter by straining all microscopic life from inflowing water by means of the tiny cilia of the gills. Then if any pathogenic bacteria, such as the typhoid bacillus, are present in the water, they are collected in concentrated form. The consumer who by chance takes such clams raw or imperfectly cooked ingests this accumulation of bacteria, with the possibility of serious results. Fortunately, in the majority of instances the clam before being eaten is subjected to a sufficiently high temperature to destroy pathogenic bacteria. Undoubtedly in the case of the clam the danger of infection from contaminated waters has been to some extent exaggerated in the public mind. Nevertheless, the fact remains that it has been essential to close large tracts of clam flats in the interests of the public health. The great problem which confronts us at the present time is the legitimate utilization of such areas.

Even more important than the purity of the water in which the clam lives is the application of sanitary methods in its handling and preparation for market. Yet this important consideration is neglected by the general public. The clammer is hardly to be criticized for ordinary negligence in sanitation, since the average man, if placed under similar circumstances, would commit similar indiscretions from lack of knowledge. Nevertheless,

in justice to the majority of clammers of this Commonwealth, the few who are guilty of practices directly prejudicial to public health should be restrained. Whoever either through carelessness or ignorance sends clams to market from an unsanitary environment potentially injures not only the health of the consumer but the business of every man engaged in the clam fishery. When the public fully realizes the importance of the use of proper care in marketing shellfish, the fishermen as a class will reap the reward of diminished trade resulting from the careless neglect of the few.

Clams are marketed in two ways: in the shell as "steamers" or shucked. In the case of the first class the danger of contamination in transit is negligible provided the clams are dug from clean flats, properly handled, washed with pure water, and packed in clean barrels for market. With shucked clams the sanitary condition of opening shanties is essentially important, since chances of contamination are greatly enhanced. Such places should receive systematic and thorough inspection. For the most part they comprise small shacks or cabins, where the clams are opened for market, and in these absolute sanitary cleanliness should be maintained. The opener in the typically unhygienic and unclean shanty usually sits on a stool or low chair with a bucket or basket of clams beside him. In front of him is a tub of questionable cleanliness partly filled with water, which is often of such a character as to be considered unfit to drink, into which the shucked clams are thrown. The tub is admirably adapted to collection of dirt and other refuse as well as clams, and perchance if an opened clam slips to the dirty floor, it invariably is tossed with the adherent dirt into the tub. However, this case as cited may be taken as an example of the worst type of unsanitary preparation for market. Fortunately, such cases are few, but they are sufficiently numerous to warrant the inspection and regulation of the opening shanties. By the enforcement of a simple law governing the inspection of shellfish, the interests of the public, the dealers and the fishermen would all be safeguarded. Persons guilty of such deplorable practices should be made to appreciate the danger and should be instructed in the proper handling of their product.

The practice of swelling or soaking shucked clams is to be deplored. In the report upon the "Scallop Fishery" is a description of how the small yellow "eye" or adductor muscle of the scallop is soaked in fresh water until it has increased one-third

of its former size by the swelling of the tissues, and how it is converted into a plump white body more tempting in appearance to a prospective consumer. While soaking brings a temporary reward to fishermen through an increase in immediate returns, the consumer loses not only the sweet flavor of the unsoaked product, but actually receives less nourishment, since the nutritive value is also depreciated by this process. When a clam has been immersed in fresh water for several hours it increases about one-third in bulk by infiltration of the tissues with water through osmosis. This, of course, enables the clammer to materially increase the volume of his product and present to the consumer finer appearing clams. Although this practice results in loss of nutritive material and flavor it causes no danger to public health if the soaking is carried on with sanitary precautions. The only possible sources of contagion in this process would be either from the water used or the tubs, which should be harmless if clean and properly sterilized. Danger is occasioned by the use of unclean utensils and water from contaminated wells.

Chemical waste and sewage exert a detrimental effect upon the clam. The precipitation of sewage sludge renders flats unsuitable for the clam growth. The idea prevails that clams thrive most readily at the mouths of sewers, chiefly because more food is supposed to be present. In the immediate vicinity of sewers this fact is not true; the food perhaps may be more abundant, but the benefit is offset by a great preponderance of suspended organic material in the water, which renders proper feeding a mechanical impossibility. The putrefactive changes which organic matter undergoes indirectly have a detrimental effect upon the clam growth. The waste products of gas factories, chiefly that of water-gas tar, have been shown to destroy oysters, and, even if not fatal to clams, necessarily would have a deleterious effect by imparting a tarry flavor, credited to clams taken from certain waters entering into Boston Harbor. Perhaps the greatest damage from manufacturing wastes is in making flats untenantable for young clams. Soft silt on the surface of a flat prevents a set, and the clam larvæ soon perish in the soft ooze, while the oily film on the surface of the water probably destroys vast numbers before the swimming larvæ attain sufficient size to set. In this way good clam flats may become unproductive and the clams unfit for food.

The history of sanitary shellfish legislation is interesting as

exhibiting discrepancies between enactment and enforcement of laws. In 1901 it was enacted that the Commissioners on Inland Fisheries and Game (now the Commissioners on Fisheries and Game), whenever so requested in writing by the State Department of Health, should prohibit the taking of oysters, clams, scallops and quahaugs from tidal waters or flats of any part of the Commonwealth for such period of time as the latter might designate. The penalty for violation of this measure was a fine of not less than $5 nor more than $10 for the first offence and not less than $50 nor more than $100 for each subsequent offence. Unfortunately, the beneficial effect of this law in protecting public health by restricting sewage-polluted areas was made void by another bill in 1907 which permitted the taking of shellfish from these areas for bait, if permits were first secured from local boards of health. As a matter of fact, it is impracticable to properly enforce the law, since it is possible only in rare instances to keep any single lot of clams under surveillance from the time of digging until they have been used as bait. Unrestricted prevention of clam digging in these areas with severe penalties is the only means by which public health can be safeguarded under present conditions.

The waters in the immediate vicinity of many productive clam flats have been found to be more or less polluted, as revealed by an inspection of the clam flats of Massachusetts in 1910, at which time certain of the immediate sources of contamination were recorded. A brief outline of this 1910 survey is here given: —

The Merrimac River is one of the worst examples of the results of pollution from manufacturing sources. The cities of Lowell and Lawrence and Newburyport have for years emptied wastes into this river. This condition, in addition to dam obstructions, has contributed to the extinction of the salmon, shad and alewife fisheries in its waters. At the mouth of this river on the south bank lie the extensive Joppa Flats, some 1,080 acres in area, while on the north bank are the Salisbury Flats, covering 250 acres. The immediate source of pollution is the city of Newburyport, as but few culverts empty into the river on the Salisbury side. The sewage system of the city consists of 2,215 regular drains, 3,144 connections, 30 culverts and 2 mains, one of which empties directly upon the clam flats. In addition to this 25 private sewers empty into the river. Twelve manufacturing plants, distilleries, shoe and cloth mills discharge their waste wholly or partially into the stream. In spite of the polluted nature of the water quantities of clams are dug for market from these

flats, and the only remedy for this unsanitary and even dangerous state of affairs is the proper regulation of the sources of pollution by the different cities.

At Ipswich 100 private sewers, 10 public sewers and the sanitary systems of 2 mills were found to empty into Ipswich River. Dyes and other refuse from 2 woolen mills and part of the waste from a gas factory add to the pollution. Fortunately, the greater part of the clam flats are 2 to 3 miles from the source of this pollution, and for that reason the marketed clams are reasonably safe, but for the good name of "Ipswich clams" these sources of pollution should be removed.

The only pollution entering Essex River is a small amount of refuse from 2 shipyards and from street culverts. At Gloucester the waste from 2 factories and the sewage from a hospital and a number of summer cottages are discharged into the Annisquam River. The major portion of the contaminating material is emptied into water that does not affect the clam flats. The clam fishery between Gloucester and Lynn is so insignificant as to render a consideration of the question of pollution superfluous. Lynn and Boston harbors have already been adjudged unfit and set aside by the State Department of Health. In the case of Plymouth Harbor the sewer empties about 50 feet from the shore. In addition to this a gas house, 2 woolen mills and the Plymouth Cordage Works empty refuse into the harbor. At Wareham an electric power plant empties refuse into the Agawam River, while at Edgartown 4 small sewers discharge near the clam flats. In the vicinity of Mattapoisett a schoolhouse sewer leads to the water. Owing to the tremendous amounts of pollution entering the Acushnet River from New Bedford and Fairhaven this stream has previously been closed by the State Department of Health.

The Taunton River conveys sewage and manufacturing wastes from Taunton, which has 29.7 miles of sewers and a population of 30,067, from a bleachery and paper mill at North Dighton, and from private sewers at Somerset. The city of Fall River, with a population of 115,097, in addition to its 71.35 miles of sewers emptying by 11 mains directly into Mount Hope Bay, contributes the wastes from 8 large manufacturing plants.

## Movements.

The movements of the clam may be grouped into two classes, the burrowing of the adult and the migratory activities of the young. Occasionally the adult is turned out of its burrow by

the clammer or by natural agents, but its anatomical structure renders it unfit for any movement except downward in the sand. Therefore the culturist is certain of retaining a planted bed unless his grant is situated in an exposed location.

When the clam is exposed on a flat by a clammer, it lies inert until covered by the rising tide. When once immersed its activity begins. From the anterior end of the shell, opposite the siphon or "snout," is extended a small white arrow-shaped organ, the foot, which has been enlarged several times its normal size by engorgement with fluid from the rest of the body. The extended foot works down between the sand grains and slowly lifts on end the shell, which disappears into the soil in a series of jerks by a pulling action of the foot. At Monomoy in coarse sand measuring from the surface of the soil to the uppermost point of the shell, 38-millimeter clams averaged a depth of 4.07 inches below the surface, 64-millimeter, 5.53 inches, and 75-millimeter, 5.73 inches. Clams in a pure sand flat apparently live at a deeper level than in a mud or gravel soil.

The length of time for burrowing depends upon three factors: (1) the size of the clam, (2) its activity, and (3) the character of the soil. Large clams take longer to burrow as they are less active, have a greater displacement, and owing to the relatively smaller size of the foot require more propelling force to enter the soil. From the standpoint of the planter, Mead (16) has carefully studied the burrowing of clams of different sizes under various conditions. His results showed that the larger clams take longer to burrow than the smaller clams and that a smaller percentage bury themselves. In transplanting clams he found it best to keep the small seed in moist seaweed, and plant them on unfurrowed soil, allowing them to burrow naturally instead of ploughing them in.

The consistency of the soil regulates the speed of burrowing, as harder soils make the entrance of the clam more difficult. In addition to age, the activity of the clam is governed by the temperature of the water, cold producing a state of torpidity. When the temperature of the water runs below 45 to 50 degrees Fahrenheit they burrow more slowly, and often lie exposed on the surface, a fact which culturists should bear in mind when planting during winter months.

Clammers report that in winter clams burrow more deeply into the soil and work toward the surface in the spring, but this observation has not been verified by the writer. The depth at

which a clam is buried is dependent upon its size and the nature of the soil in which it lies. Doubtless clams are found at a lower level in winter, owing to increased growth during the previous summer, but there is no evidence that they rise in their burrows.

The young clam on reaching the attachment stage has relatively a much larger foot than the adult, which enables it to creep or burrow in the sand. Kellogg (4 and 6) has demonstrated in at least a large percentage of cases that the young *Mya* passes through a migratory stage in its existence, during which it attaches itself to seaweeds or other substances by its byssus before it finally settles into the sand. He says: —

The small clams are restless, and apparently always desire to creep about. Though the [byssus] threads are many times the length of the body, they allow of little movement. From time to time the thread is cast off, for, once attached at its ends to sand grains or other bodies, it cannot be loosed. The clam then creeps about by means of its foot, but soon spins a new thread, at the same time attaching it by its free ends. This may be repeated many times, as the clam never remains for any length of time unattached.

Very early the young clam manifests the digging instinct. Being a helpless creature, and subject to attack by enemies (notably small starfish), it is necessary that it should cover itself in the bottom as soon as possible. When but little more than a millimeter in length, the creature thrusts its tiny foot down between the sand grains in a tireless effort to obtain a lodgment. This cannot be accomplished, however, for the light body is still not much larger than the sand grains which it attempts to displace. When a length of 2 or 3 millimeters is reached, the body is sometimes partially or perhaps wholly covered, if the sand of the bottom is very fine. When a length of 6 or 7 millimeters is reached, a clam is able to dig below the surface on any bottom, and is able to cover itself with much celerity.

Even in its burrow, the small clam exhibits a strange restlessness. It repeatedly casts off the byssus from its body, digs out to the surface, and creeps away, only to go down and again attach itself.

The ordinary crawling of the young clam, like that of the quahaug, is accomplished by a pulling movement of the foot. The small clam opens its valves, stretches out its foot hesitatingly, lashes it to and fro for a second, and then applies the distal end to a suitable resting place. In this position the two retractor muscles of the foot are relaxed. The remainder of the foot, with the elbow-like byssal gland, is extruded, and this

movement draws the shell down slightly and in the direction of the tip of the foot, while the anterior end of the shell, that nearest the foot, tips down toward it. This movement is due to contraction of the anterior retractor. Then as the posterior retractor shortens, the foot is drawn into the shell, which results in advancing the shell as far as the distal end of the foot, and causes it to assume its original position, having covered a distance corresponding to the length of the extruded foot. Half-grown *Gemma* and young *Venus mercenaria* have been observed to employ similar movements, and very probably many lamellibranchs use this means of locomotion during early life. Young *Amonia* and *Pecten* travel by means of a straight pull with the foot with no tipping of the shell, due either to the absence or lack of development of the anterior retractor muscle of the foot. The backward movement described for the quahaug in a previous report is likewise performed by the clam. In observing a 0.7-millimeter clam it was ascertained that the average movement took 5.1 seconds, the longest 10, and the shortest 2. Two or 3 millimeter clams burrowed within one minute from time of first extending the foot.

The clam less than 1 inch in length is not imbedded in the soil deeply enough to prevent washing out and the animal is thus frequently forced to migrate. Many of our experimental beds have been filled with small clams from neighboring localities, a condition which often caused confusion in the records of the planted clams, and rendered difficult the determination of set. Clams on rippled wave-washed flats are occasionally carried away before they attain adult size, a difficulty with which the prospective culturist must contend. At Plymouth and Wellfleet seed clams were washed out and completely disappeared from the beds on exposed flats. Therefore it may be considered that the movements of the young clam depend upon its size, its environment and natural forces being brought to bear upon its existence. But once having attained a size sufficient to burrow deeply in the soil, it loses its power of voluntarily moving from place to place.

## Recovery from Injury.

Frequently clams are broken in numerous ways by the inexperienced and occasionally by the experienced clammers. Unless the fracture is too extensive the wound is healed by the formation of a layer of new shell inside the old. Though the

old crack never joins it is held together by substratum of new growth, secreted by the mantle. Usually the breaks are more serious than mere cracks, and being unable to burrow the clam perishes on the surface of the flat. In a few tests made at Monomoy Point with broken clams various sorts of shell wounds were found to heal. One test consisted in mutilating large and small clams in five different ways, viz., breaking the edges of the shell, puncturing a small hole just below the umbo, clipping a piece from the tip of the siphon and breaking the anterior and posterior ends of the shell. Small clams exhibited greater recuperative powers than the large, as 43 per cent. of the former recovered as compared with 30 per cent. of the latter. None of the small clams recovered after breaking shell edges, while 40 per cent. of the large clams similarly treated were alive after one month; 83 per cent. of the small clams recovered after having a small hole drilled through the shell below the umbo, while none of the large clams survived; 50 per cent. of the small clams and 60 per cent. of the large recovered after removal of a piece from the tip of the siphon; 25 per cent. of the large clams and 42 per cent. of the small recovered after having the ends of their shells broken. It is well for the clam culturist to realize that slight breaks are not necessarily fatal to the clam and that for this reason broken ones should not be wholly discarded.

### The Food Value.

Clams are shipped to market both in the shell, as "steamers" and "shucked." Naturally the consumer is interested in quantity and quality of clam "meat" rather than in the appearance of the shell, in spite of the fact that the clammer markets the attractive sand clam in the shell while he "shucks" the less prepossessing mud clam. Since in our growth experiments we have dealt only with the increase of the shell, it might perhaps be interesting to consider the relation between shell and meat in the different varieties of clams.

To determine the ratio between meat and shell simple tests were made on clams of five sizes between 45 and 85 millimeters in length from four localities, Newburyport, Ipswich, Essex and Plymouth. The method of work consisted in (1) obtaining the desired sizes from freshly dug clams, care being taken to select no abnormal specimens; (2) determining the total weight; (3) the removal of the meats, fluid and waste, in the customary market manner; (4) weighing the meats and waste; (5) record-

ing the natural conditions of the flats from which clams were taken; and (6) obtaining the volume of the different parts by water displacement.

According to the results of Atwater and Langworthy (16) the clam in the shell shows a composition of 43.6 per cent. refuse material, 48.4 per cent. water, 4.8 per cent. protein, .6 per cent. fat, 1.1 per cent. carbohydrates and 1.5 per cent. mineral matter, making the total nutrients 8 per cent. Canned clams were found to contain 84.5 per cent. water, 9 per cent. protein, 1.3 per cent. fat, 2.9 per cent. carbohydrates and 2.3 per cent. mineral matter, thus affording 15.5 per cent. of nutritive material, which is greater than that of the canned oyster, with 14.7 per cent., and less than the canned quahaug, which averages 17 per cent.

*The Meat.* — As with the quahaug, the greater part of the solid contents of the clam is used as food. The waste portion consists solely of the tip of the siphon, the edge of the mantle, and a portion of the adductor muscle left adhering to the shell, which in all amounts to 5.04 per cent., while the edible portion averages 34.55 per cent. of the total weight. With increasing age the flesh, particularly in the region of the siphon, becomes yellow and tough, which tends to render an old specimen, not necessarily a large clam, less palatable.

Among future possibilities is the production of clams with characteristic flavors, since it is believed that the various species of microscopic plants present in the water give a diversity of flavor to mollusks. When more detailed information concerning the food of the clam is available it may be possible to do much towards the creation of such special flavors by artificially cultivating these particular food forms. In this connection it may properly be mentioned that the presence of oils, chemicals and other manufacturing wastes frequently render the flesh of clams distasteful.

*The Shell.* — The material for shell formation is assimilated by the tissues of the body from the inorganic salts which are in solution in the water and then deposited as shell. Soil is not absolutely essential for shell formation, since clams have been found to grow when kept without sand, in wire baskets suspended in the water. The character of the soil, as shown below, indirectly exerts an appreciable effect upon the type of shell formation. The rate of growth is also important, as the more rapidly growing clams possess a lighter and more delicate shell.

As the clam increases in size the weight of its shell in terms of the total weight relatively increases but slightly, since the older shell is heavier, except where its substance has been corroded by organic acids in the soil.

The following table gives the values in per cent. by weight for an average 60-millimeter ($2\frac{2}{5}$ inches) clam in different classes of soil. From 100 pounds of clams by weight the consumer obtains 34.55 pounds of meat.

*Influence of Soil.*

| | Shell. | Meat. | Waste. | Fluid. |
|---|---|---|---|---|
| Sand, | 50.41 | 37.74 | 5.11 | 6.74 |
| Sandy mud, | 50.82 | 37.79 | 5.25 | 6.14 |
| Mud, | 53.46 | 32.43 | 4.60 | 9.51 |
| Gravel and clay, | 57.98 | 30.24 | 5.19 | 6.59 |
| Average, | 53.17 | 34.55 | 5.04 | 7.24 |

While it is impossible to eliminate the influence of current upon clam growth, the above table indicates the general effect of different types of soil upon the shell. First, the sand clam has the lightest shell, sometimes styled the "paper shell." Secondly, the sandy mud clam in some localities, where the soil is little more than a tenacious sand, varies little from the pure sand clam. Thirdly, the mud clam has heavier shell and greater width. Fourthly, the gravel clam has a characteristically rough, heavy shell. The general shape and appearance of sand and mud clams are radically different. The mud clam is wider and appears to have grown more sluggishly than the smooth, slim sand clam. The shell of the gravel or stony flat clam is rough and heavy, and often shows marked deformities. Possibly this strength and ruggedness have been necessitated by the irritating nature of its environment. As the weight of the shell increases that of the meat proportionately decreases, and though the difference is not entirely accounted for by the increased weight of the shell, more value may be obtained by the purchase of sand clams by weight than either the mud or gravel. As the clam increases in size it changes but slightly the relative proportion of its parts, as may be deduced from the table below. While the shell becomes comparatively heavier the meat likewise increases in weight, with a corresponding decrease in the waste material.

| Size (Millimeters). | Shell (Per Cent.). | Meat (Per Cent.). | Waste (Per Cent.). | Fluid (Per Cent.). |
|---|---|---|---|---|
| 45, | 52.80 | 32.08 | 5.62 | 9.50 |
| 55, | 51.94 | 35.24 | 5.12 | 7.70 |
| 65, | 53.87 | 35.71 | 5.05 | 5.37 |
| 75, | 54.04 | 35.17 | 4.37 | 6.42 |

*Comparative Food Value.* — In a comparison of the food values of the clam, quahaug and scallop it is necessary to eliminate fluid volume from consideration, as with the scallop this is an uncertain quantity. Again, only the adductor muscle of the scallop is eaten, while the entire solid contents of the quahaug and clam are consumed. Considering the weight of the shell and the edible content, the latter, though practically the same weight for weight in both the quahaug and scallop, being 17.85 per cent. for the quahaug and 17.77 per cent. for the scallop, is much higher for the clam, in which the edible portion is 37.24 per cent. The weight of the quahaug shell in considering such values is 82.15 per cent., that of the clam 57.32 per cent., and of the scallop 49.43 per cent., while the soft nonedible parts of the clam amount to 5.44 per cent. and of the scallop to 32.80 per cent.

| | Shell (Per Cent.). | Edible Meat (Per Cent.). | Nonedible Meat (Per Cent.). |
|---|---|---|---|
| Clam, | 57.32 | 37.24 | 5.44 |
| Scallop, | 49.43 | 17.77 | 32.80 |
| Quahaug, | 82.15 | 17.85 | – |

## CLAM CULTURE.

*The Decline.* — The diminution of the natural supply has been brought many times to the attention of the general public by the difficulty in obtaining good clams at a reasonable price. In certain localities laws safeguarding the public health, by restricting the area of productive clam flats, have brought about a decline, but in a general sense the decrease in the natural supply has been caused by the lamentable practice of overfishing. Even in the towns of Newburyport, Rowley, Essex and Gloucester, the best clam producing sections of the Commonwealth,

the natural supply has shown signs of failing. South of Boston the depletion of the clam beds has been even more noticeable. A striking illustration of this condition is furnished by Plymouth Harbor, where a vast area of flats which formerly yielded the famous "Duxbury clams" is now barren and practically unproductive. The Buzzards Bay district barely yields sufficient to supply home consumption, and the same is true of the shore of Cape Cod. For a detailed statement of this decline the reader is referred to the report on the "Mollusk Fisheries" for 1909.

The specific causes of the decrease in the clam supply can be readily enumerated: (1) the destruction of certain productive flats by natural forces, such as shifting sand, changing currents and heavy storms; (2) the restriction of productive areas, owing to sewage pollution; and (3) the exploitation of the natural clam beds by overdigging, a direct result of the increasing popularity of the clam as a sea food.

*The Remedy.* — Not only the clammers but the consumers as well may properly ask what can be done to increase the supply of clams. The Commissioners on Fisheries and Game now submit a plan for regulating the clam-producing territory of the Commonwealth. In brief, it is to restore the barren and unproductive flats to their former thriving condition by planting clams, in this way preventing the inevitable decline and even producing a greater supply than under natural conditions. Experiments have demonstrated that clams may be successfully transplanted and that their cultivation is a practical undertaking. Not only may barren areas be restocked and made fruitful, but the slender harvest of the mildly productive areas can be notably increased.

To accomplish this end it will be necessary to radically change the conditions now prevalent in the clamming sections. There is no question but that clams can be profitably transplanted and grown; but their extensive culture cannot be instituted except along systematic lines, which means that the individual fisherman must supervise the operations of transplanting, seeding and harvesting the crop. All that he lacks is the necessary land upon which to raise clams, a deficiency which may be remedied by timely legislation. To the clammer, this change signifies elevation from a chance gatherer of shellfish to the plane of a practical culturist. In other words, a waning industry would be revived, and the clammer would receive a tract of land for a clam garden, with the assurance of obtaining the fruits of his

labors. Only with absolute protection can the clam flats under a system of clam farming be made to yield their normal harvest, but this system can be inaugurated solely by the passage of legislative measures, more liberal and specific than any on the present statute books for the proper regulation of this infant industry.

A choice between private and public management of clam culture must be made before the problem can be satisfactorily solved. Two methods of procedure are available: (1) the seeding of the flats at the expense of the town or of the State, with permission given to the public to gather clams after a closed season; (2) the leasing of the lands to individuals for private planting, which would be equivalent to the adoption of a system of grants. A review of the past efforts of towns to restock clam flats on a communal basis will disclose the fact that failure has resulted in practically every instance, invariably because the planting was done by men unfamiliar with such work. Although communal culture is a possibility, inherent drawbacks to such a scheme will always remain, *e.g.*, a just sharing of expenses, equal co-operation in labor, and a satisfactory division of the harvest, all of which tend to render the plan impracticable.

A more satisfactory plan is that of granting licenses to individuals by the town or by the State, allowing such persons to hold and cultivate under proper safeguards a tract of clam flat, which they shall seed and stock at their own expense. According to this method the clam-producing area of a town would be divided into two approximately equal parts, one of which would be reserved as public flats, and the other separated into small sections of a few acres each, to be leased to clam culturists at a fair annual rental. Only citizens of the Commonwealth or residents of the town in which such ground was situated would be permitted to hold these licenses. According to this plan the lease would run for a specified term of years, with privilege of renewal depending upon the efficiency with which the lessee had improved his holding. Immunity from outside molestation would be guaranteed to the licensee, who, in addition to the annual rental to the town or State, would be subject to taxes upon his holdings by the town in proportion to their assessed value.

The proposed remedy is the outgrowth of several years' investigation conducted by the Massachusetts Commission on Fisheries and Game. The results of experiments in practical clam culture show conclusively that small clams may be successfully

transplanted from one locality to another and made to grow rapidly to a marketable size with but a small outlay of capital. It has also been demonstrated that clam cultivation or farming is positively practicable and that good profits will result from judicious planting. Clam farming is therefore not a theory but an established fact. The remedial measures advocated are not a makeshift, hurriedly formulated, but are the logical consequence of several years' careful study of existing conditions along the seacoast. By its installation clam farming may be placed upon the same basis as oyster culture, to the ultimate benefit of both the fisherman and the consumer.

*Benefits.* — The following advantages to all classes are now demonstrable or may be conservatively predicted to result from the adoption of the proposed remedy: —

1. Economically the available supply of sea food will be increased, to the general benefit of the public. In Massachusetts, where the population is so dense that the people have to depend in a great measure upon other sections of the country for their supply of foodstuffs, any important article of diet native to the Commonwealth should be cultivated to its maximum production.

2. The supply of clams will be so increased as to more adequately meet the demands of the market. The clam has become a popular article of diet and there is no valid reason why it should not be more readily obtainable and at a lower price than at present. Any method of production which tends to increase the supply of this valuable mollusk is deserving of public support.

3. The product of the planted beds would tend to limit the drain on the natural beds, as many clammers who formerly dug from these flats would be supplied from their own grants, and in this manner allow nature to recuperate its own supply. Spawning clams on the private grants would enhance the value of the public flats by furnishing a greater amount of spawn.

4. Thousands of acres of barren or unproductive flats would be converted into active sources of revenue. It seems poorly in accord with prevailing methods of New England thrift that large areas along the shore, which could be made more valuable, acre for acre, than upland, should be allowed to remain unproductive. There is no question but that a division of the tidal flats into gardens for the raising of clams is as feasible as sectioning a large agricultural tract for different crops. The shore lands, by a comparatively slight expenditure of time and money,

could be changed into clam farms, which would exceed in earnings the income from tracts of the same size in rural districts.

5. The individual clammer would be benefited by having more remunerative and steady work. The natural flats, open to the public, in spite of the restricted area, would yield more clams, owing to the increased natural supply, but the unfailing and reliable source would be the private grant, from which, except under the most unfavorable circumstances, the clammer should be able to derive a respectable annual income. The value of an acre of average clam flat, if properly cultivated, is about $450 per year, although it is possible for very productive ground to yield $750 per acre. A man cultivating a grant of 1½ to 2 acres could derive from it anywhere from $650 to $900 per year, which quite surpasses the present average income of the Massachusetts clammer.

6. The cultivation of clams will inevitably advance the general prosperity of the coastal communities, where the shellfish industry furnishes the main source of income. The proposed system by insuring a steady income to the industrious fishermen residing in these communities will materially aid in general civic advancement.

The problem which now confronts us is as follows: Massachusetts possesses 11,000 acres of tidal flats potentially capable of clam production. The greater portion of this area is practically barren, unproductive of clams in paying quantities, and yet these flats, once planted with small clams, would yield in from one to two years large quantities of marketable bivalves. In the past, such methods as closed seasons and restricting the catch have been tried without success. In the case of the clam, which readily lends itself to artificial propagation, restrictive legislation alone is not only unnecessary but disastrous in its effect, and the only scientific solution of the problem is an increase in the supply, made possible by a system of clam farming based upon properly regulated private grants.

7. The uncertainty of the present free-for-all fishing will be practically eliminated. The clammer, with more or less certainty, will be enabled to estimate the exact size of his crop, and thus will be in a position to market his clams to the best advantage. Under the present system the catch has to be shipped to market at once, regardless of the prevailing prices, whereas under the proposed system the clammer is placed in a position similar to the owner of desirable standing timber in a

region comparatively safe from forest fires, and can market his product whenever he desires at his own price, in this way eliminating that often quoted bugaboo, the commission merchant.

8. In the capacity of clam culturist the attitude of the clammer toward his work will undergo an agreeable change with the realization that he will receive the direct reward of his labors, and that the fruits of this work will be for his own permanent benefit.

9. The social and economic status of the clammer will be elevated, since at present his calling furnishes at best but an uncertain and scanty income. By producing clams for the market the clammer will increase his material assets, build up his credit and establish a reputation for reliable business on the same plan as the agriculturist and manufacturer.

10. By systematic cultivation the future of the clam industry will be indefinitely assured. In this way the clammer will protect his own interests and will work out the salvation of the industry.

### The Clam Farm.

In the following pages the problems which would beset a prospective clam culturist are set forth for the enlightenment of persons who are either desirous of engaging in the business, or who are interested in the problem.

*Selecting the Ground.* — The most difficult problem confronting the prospective culturist is the selection of suitable ground. In the choice of a tract for cultivation the clam farmer should be influenced by a consideration of three important factors: (1) the capacity of the ground for rapid production of clams; (2) the advantages for work; and (3) the facilities offered for advantageous marketing of the crop. The ideal grant should be naturally adapted to the rapid growing of clams, should possess ready facilities for work and should be located reasonably near a good market. Unfortunately, such a delightful combination of advantages is not common, and the culturist will probably have to choose a grant with such qualities as he thinks best suited to his particular needs. For this reason it is perhaps well to explain in greater detail these three factors.

(1) *Productive Capacity.* — The foremost consideration in the selection of a grant is its productive capacity, which is based on three conditions: (*a*) favorable soil, (*b*) water currents, (*c*) minimum exposure at low tides.

A good flat should have a tenacious and compact soil which

nevertheless would afford comparatively easy digging. Perhaps the best consistency is a mixture of fine sand and mud in a ratio of one-third mud to two-thirds sand, which supplies the proper degree of tenacity. The nature of the soil, which acts as the supporting receptacle for the clam, affects it in two ways: (1) if too shifting it buries the clam too deeply or washes it out of its burrow; (2) soils in which organic acids, caused by vegetable decay, are present prove unsatisfactory for the catching of seed and interfere to a slight extent with growth by destroying the shell, often giving to the clam a black appearance, making it less favorable for marketing. Although the shell of the clam is secreted by the lime salts absorbed from the water, nevertheless, the nature of the soil in some indirect way determines the appearance, the composition and the weight of the shell, as can readily be seen by comparing clams from various soils in the same localities.

The growth of the clam depends chiefly upon the circulation of water, as the current bears both food and oxygen, and therefore, within limits, the more current, the more food, a fact which is fully explained in the section relating to the growth of the clam. The clam obtains its sustenance from the water, feeding almost exclusively upon minute marine plants (diatoms), which in turn derive their nourishment from the nitrogenous waste products which pass into the streams from the land. The currents also keep the ground clean and prevent the spread of contamination and disease. It is highly desirable that the grant should be located where there is a steady current, such as can be found over river flats, since the rate of growth of this mollusk depends directly upon the circulation of water. It is possible for a flat to be washed by too rapid a current, which causes a shifting of the bottom and washes the clams out of their burrows. However, such conditions exist in but few localities where one would consider planting.

The growth of the clam is more rapid on ground seldom exposed by the tide, since the clam is able to feed only when the water is over its siphon. Our experiments have shown that clams grow faster when continually under water than when partially exposed. The question of exposure is not as vital a problem as that of current, and the most satisfactory conditions for clam culture are found on a fairly high flat which has a good circulation of water, a tenacious soil and which affords a reasonable time between tides for digging.

(2) *Facilities for Work.* — The second important consideration, facilities for work, comprises (*a*) accessibility, and (*b*) a suitably long period between tides for digging. If possible, the grant should be readily accessible from the home of the culturist, so that he may have access to it without loss of time and have protective oversight. That grant is most desirable which by virtue of its location offers the greatest possible length of time between tides for labor. In this respect there is great variation, high flats being exposed for hours, while low flats are often uncovered. The former offers the advantage of a longer working period to the clammer, but at the same time possesses the disadvantage of less rapid growth.

(3) *Proximity to Market.* — It is an extra asset if the grant affords facilities for an easy disposal of the crop. Certain clam flats have the advantage of being near city markets and have advantages for shipment, which result in greater net profits than is the case with the more remote grants. The parcel-post system should prove of value to the clam culturist in making small shipments of clams in the shell, or "shucked," to the individual customers, thus doing away with excessive express charges.

*Proximity to Seed Clam Supply.* — The cost of obtaining a supply of seed clams is worthy of consideration. If a grant can be chosen so as to be near an area of natural set, where seed clams may be readily obtained, it will do away with the difficulty of transporting seed from remote beds. The culturist should also consider the possibility of so modifying his grant as to turn it into a natural spat collector, and in this way make Nature seed the flat.

*Pollution.* — It is important that the location of the grant be far removed from sources of pollution, which inevitably results in serious depreciation of the market value of the clams when the fact that the grant is situated in contaminated waters becomes publicly known. In the future rigid inspection of marketed shellfish will be instituted, which will result in the exclusion of clams deemed dangerous to the public health. In connection with this the clams from particular localities and with particular flavors should be permitted to be marketed under registered trade names and under suitable laws, prohibiting improper substitution and false representation.

*Preparing the Grant.* — Usually the ground needs no preparation previous to the planting of the clams, although the removal

of cockles, horseshoe crabs and other enemies which might prove detrimental is a wise precaution. Often the culturist will find that the grant needs such preliminary treatment as the removal of eelgrass, sanding, providing drainage, and other similar prerequisites before it can become a productive clam flat.

*Procuring the Seed.* — The set of clams is usually restricted to certain localities which vary from time to time in the amount of seed clams. Heavy sets are generally found in limited areas, in one instance running as high as 2,000 per square foot of surface, and covering an area of nearly 3 acres. Natural flats are in part supplied with young clams from these areas, but nature unassisted is extremely wasteful, depending upon the washing out of the seed from the areas of thick set and the chance depositing upon receptive soil. Often whole sets are wasted because the young clams, instead of being washed upon favorable ground, are carried to unsuitable flats, where they soon perish. In this way heavy natural sets often contribute practically nothing to the reseeding of barren flats. These regions of heavy set occur to a greater or less extent in almost every harbor on the coast, and it should be the concern of every clammer to check this natural waste by correctly utilizing the seed clams. Clam farming presents a means of saving natural sets by transplanting the seed to favorable soil, in this manner making lucrative the barren flats.

*Spat Collecting.* — Methods of spat collecting have been presented in reports of the Rhode Island Commission of Inland Fisheries and unintentionally the impression has been created that clam farming will never be successful until some practical method of spat collecting is devised. In the case of the soft clam there is no immediate necessity for a method of spat collecting. The problem here is the proper utilization of the enormous natural sets, which are even more than sufficient to restock the barren flats. The solution is rendered difficult by lack of a rapid method of obtaining the small clams. Since the character of the soil and the size of the clams vary, no one method is applicable in every case, and upon the ingenuity of the individual planter depends the success in overcoming obstacles presented by a particular locality. The methods of set gathering employed at the present time are: (1) the slow process of digging the small clams with an ordinary clam hoe; (2) the somewhat quicker method of digging the set in shallow water in such a manner that the clams are washed out of the soil; (3) the mak-

ing of trenches across thickly set flats into which the clams are washed by the action of the tide and wind; (4) the transporting of both soil and clams to the new ground; and (5) the sifting of the clams from the sand by means of a cradle, as is described in detail in the section dealing with the Rowley Reef set.

*Transportation of Seed Clams.* — In cases where the seed has to be carried many miles by rail extreme care must be used in transit, since the shells of small clams are extremely fragile, especially the sand varieties, which are therefore less favorable for transportation than the same species from gravelly, stony or muddy soil. The length of time that they will live out of water depends upon the temperature; in cold weather they will live several days (clams have been kept for several weeks at a low temperature); in warm weather they will be in poor condition after being out of water for even one day. For rapid burrowing it is essential that the clams be in good condition when planted. The best method of shipping seed clams is by packing them in damp seaweed, a more successful method than keeping the clams in water. Perhaps the safest way is to pack the clams in light crates such as are used for strawberries, but this method is open to the objection of expense and excessive amount of time consumed in packing. In transplanting clams for certain experimental beds of this department, seed clams were shipped in good condition 150 miles. In our method of packing ordinary barrels were divided into three compartments by means of two crossbars set at right angles, and nailed firmly to the sides of the barrel. On these crossbars circular pieces of wire netting were laid and over the netting was strewn a layer of rockweed or eelgrass. A piece of ice about the size of a two-quart measure was placed in each division and holes were bored in the bottom and sides of the barrel. The netting might well be eliminated as the rockweed resting on the cross pieces is sufficient to prevent the clams grinding together. Less than 3 per cent. thus shipped were damaged, and when sown nearly all burrowed rapidly, showing that they were in excellent condition in spite of the fact that they had been out of water over twenty-four hours. Twenty-one bushels were shipped in nine barrels, averaging two and one-third bushels to each barrel.

*Planting.* — The operation of planting consists merely of sowing the seed clams upon the surface of the flat. The small clams when covered by the tide will rapidly burrow into the soil if in good condition, and require no further attention. Certain classes

of soils require raking over the surface to facilitate the burrowing and prevent their "clumping" by the tide. For the experimental beds the arduous, time-consuming method of planting the individual clams by making holes in the soil with the finger or with a stick was used, but for practical use it is scarcely worth considering. The practice of ploughing the small clams under, in deep furrows, an erroneous application of agricultural principles, is to be avoided. Dr. Mead (16) of the Rhode Island Commission of Inland Fisheries, upon investigation of this method of planting, found that when the clam had been buried sidewise or the wrong end up it had difficulty in righting itself, especially if it were a large specimen, and concluded that this method was at best unsatisfactory. The results of our experiments favor the method of sowing by hand, with due regard for such factors as the tide and force of the tide, the nature of the soil, and the freshness of the seed.

A novel method of planting was used at Wellfleet, which well illustrates the necessity of adapting the method to the particular locality. Here the flats which line the head of the harbor from Duck Creek to Herring River are exposed to the influence of southerly winds, and for this reason are slightly shifting. If clams were sown here in the usual manner the incoming tide would roll them in windrows upon the beach before they would have time to burrow. Although this difficulty could be avoided by the selection of a calm day for planting, it is usually imperative that the planter work immediately, before the seed perish. This problem was solved by planting at half tide, when water was at least 3 feet deep over the flat. At this depth the clams on the bottom remained undisturbed by the motion of waves in an ordinary breeze. All planting was done either from boats or by wading in the water. A comparison of the two methods was made, and in spite of the fact that the flats had been well raked over to afford a resting place for the clams, and though the wind was not blowing hard, many of those planted on the dry flat were washed for a distance of 200 feet. On the other hand, clams planted when the water was over the bottom deeply enough to prevent a ripple were not washed off the bed. The method of planting clams in ploughed furrows was tried by the town on these flats and resulted in many of the clams being washed out of the furrows and collected in bunches, while the soil became soft and temporarily unsuitable, a condition which illustrates the undesirability of such a method in this locality.

*Harvesting the Clams.* — Once planted, the clam crop requires less toil on the part of the planter than does the raising of produce for market. Cultivation is unnecessary for the rapid growing clam, and, in fact, they grow better when left undisturbed. However, protection from poachers and natural enemies demand the attention of the owner at all times. The time of harvesting, in a general sense, depends upon the size of the clam, but, unlike other crops, clams undergo no deterioration if not harvested during a certain season. By digging certain sizes the farmer can cater to a particular trade or demand, as in some instances he may find it profitable to market a small clam after a short period of growth, while on other occasions it may be of a greater advantage for him to sell large clams. This situation is very similar to that of the farmer who harvests his crop of cucumbers in two sizes, the smaller for pickles and the larger ones for table use. Since the greater growth takes place during the summer months, a clam culturist may control his seed and its rate of growth so as to obtain clams of desired size in six, eighteen or thirty months.

*History of Clam Farming.* — The idea of artificially raising clams is not new; past years have witnessed attempts at clam culture; but it is a noteworthy fact that all conspicuous experiments up to date resulted from legislation aimed to protect the cultivator's right to his crop. The prevailing idea seems to have been that such enterprise could not successfully be launched without a lease from State or town, by virtue of which the planter might protect the fruits of his labors. Although acts purporting to give such desired protection have been passed, examination of the records have shown them to be either invalid or not enforced.

The first record of any legislation upon this subject is an act regulating the clam fishery of Plymouth Harbor, passed in 1870, whereby clam planting and the distribution of licenses was authorized. Only in recent years has this opportunity been taken advantage of. In 1874 a similar act was passed governing the shellfisheries of Mount Hope Bay, but it was repealed the following year. In 1888 the town of Winthrop was empowered to give 2-acre grants, and in the same year the town of Essex was endowed with a similar right. Each and every one of these acts clothed the respective town with authority to regulate such licenses unrestrictedly.

In substance the Essex act was the most liberal, and several

fishermen, after procuring licenses, successfully started clam cultivation. As the licenses in these cases were not sufficient protection from trespassers, these clam grants were given up after a few years. Nevertheless, the attempt served to prove that clam farming properly protected would be profitable. In 1906 the barren flats in Essex River were again leased under the same act, protection being afforded by general sentiment against poaching and mutual agreement to respect individual rights. Since that time clam culture has been carried on with more or less success. The history of clam culture in Essex is given more at length in the "Report upon the Mollusk Fisheries," 1909. However, the Essex system may not be practicable on a large scale or in every community, and need of protective legislation is still urgent, to say the least.

Lack of protection, which discouraged the early Essex planters, has had similar results in other shore towns where attempts at clam culture have been made, and it may be stated unreservedly that until protection is guaranteed clam farming may never become more than a possibility. The present law is in no sense a safeguard, as according to its precepts all persons have an inalienable right to dig clams anywhere between the tide lines. No clammer will expend labor and money to plant clams if another has a legal right to dig them. Clam culture can never become a successful industry until a law is passed to protect the planter from trespassers.

By the year 1911 several coast towns had seriously taken up the problem of clam culture, and many enterprising men had ventured into the new business. These pioneers, with but feeble legal backing, are now bringing the inhabitants of the Cape Cod towns to a realization of what may be done with the now unproductive flats along the shore. As a result more men are entering the business, even with full recognition of their slender chance for redress in case of injury by trespass.

Not all towns are actuated by the same progressive principles existent in Barnstable, Plymouth, Kingston, Duxbury and Essex, the only towns which have taken advantage of the special acts of the Legislature by leasing small sections of barren flats to their citizens. The results of such efforts in the town of Barnstable are eagerly awaited by other towns on Cape Cod, and if success is the reward in this novel departure it is to be expected that many will quickly follow its example. Already great strides in quahaug culture have been made in Chatham, Harwich, Barn-

stable and Swansea, as well as in many of the Buzzards Bay towns. The fact that quahaug culture is now safely under way augurs well for the future success of clam farming.

Interest in this new enterprise is strongly manifesting itself on Cape Cod. Premiums are now offered at the Barnstable County Fair for the best cultivated clams, quahaugs and oysters, and in 1912 genuine enthusiasm was aroused over the shellfish exhibitions and competition for these prizes was very keen. Proper protective legislation is greatly to be desired by way of encouragement to these planters.

## Clam Laws.

Up to the present time legislation governing the shellfisheries of this Commonwealth has been of a desultory character. Now and then the requirements of the industry have called forth new legislation, confined in scope to the relief of adverse conditions in particular localities or pressing monetary needs. As a result of this narrow policy the welfare of the shellfisheries in general has suffered, and the results are now very apparent. Unquestionably the shellfisheries are heavily burdened with antiquated and obsolete laws which hinder possible improvement.

In the past clam legislation has been necessary only as a protective measure, while now we have reached the point where legal regulation of clam fishing is to play an important role in the development of the industry. In one sense it is entering upon a new and critical phase of its existence, the cultural stage, and true advancement will henceforth be measured by the impetus given by numerous laws governing the leasing, planting, pollution and sale of clams. For this reason it is well to consider the extent of the previous protective legislation.

*History.* — The fundamental principle upon which the shellfish laws of the State are founded is the so-called beach or free fishing rights of the public. While in other States property extends only to mean high water, in Massachusetts the property holders own to extreme low-water mark. Nevertheless, according to further provisions of this ancient law, the right of fishing (which includes the shellfisheries) below high-water mark is free to any inhabitant of the Commonwealth.

(1) *Origin.* — The first authentic record of this law is found under an act of Massachusetts in 1641–47, by which every householder was allowed "free fishing and fowling" in any of the great ponds, bays, coves and rivers, as far "as the sea ebbs and

flows," in their respective towns, unless "the freemen" or the General Court "had otherwise appropriated them." From this date the shellfisheries were declared to be forever the property of the whole people, *i.e.*, the State, and have been for a long period open to any inhabitant of the State who wished to dig the shellfish for food or for bait.

(2) *Early Benefits.* — In the early days, when the natural supply was apparently inexhaustible, and practically the entire population resided on or near the seacoast, it was just that all people should have common rights to the shore fisheries. As long as the natural supply was more than sufficient for the demand, no law could have been better adapted for the public good.

(3) *Present Inadequacy.* — Two hundred and fifty years have passed since this law was first made. The condition of the shellfisheries has changed. No longer do the flats of Massachusetts yield the enormous harvest of former years, but lie barren and unproductive. The law which once was a benefit to all has now become antiquated and incapable of meeting new conditions.

(4) *Evil Effects.* — If this law were merely antiquated, it could be laid aside unnoticed. On the contrary, as applied to the present conditions of the shellfisheries it not only checks any advancement but works positive harm. From the mistaken comprehension of the so-called beach rights of the people, the general public throughout the State is forced to pay an exorbitant price for sea food, and the enterprising fishermen are deprived of a more profitable livelihood. The present law discriminates against the progressive majority of fishermen in order to benefit a small unprogressive element.

*History of Legislation.* — The clam, with the scallop, oyster and quahaug, was grouped under general shellfish legislation in acts which fall naturally into the following divisions: (1) town regulation; (2) permits; (3) seizure in vessels; and (4) the protection by limitation of catch, place and time of taking.

The clam is first mentioned in the Public Statutes under an act of 1870 regulating the clam fishery in and around the shores of Plymouth, Kingston and Duxbury. Although this act was substantially the same as the Essex act of 1888, printed in another section of this paper, it excepted the specification that the grants made should be on "unproductive" flats, and is now in force. The towns embraced within the scope of this act regulate their clam fisheries according to its provisions, which are in brief: (1) Five-year licenses to be granted to any inhabitants to

plant, cultivate and dig clams. (2) Such benefits to be bestowed subject to the discretion of the selectmen. (3) Grants to be given on any flats or creeks in respective towns of applicants. (4) Licensed territory to be described by metes and bounds, and recorded. (5) Payment of a $2 fee to the selectmen and 50 cents to the town clerk for recording. (6) Protection and treble damages to be adjudged in an action of tort against any person digging or taking clams from grants without consent of the owners. (7) Towns may make such by-laws as expedient to adequately protect the shellfisheries. (8) Penalty for each offence not less than $5 nor more than $10, with cost of prosecution, and $1 for each bushel of shellfish taken in violation of the provisions of this act.

In 1874, in a legislative act "to regulate the shellfisheries in the waters of Mount Hope Bay and its tributaries," the selectmen of towns bordering on Mount Hope Bay were permitted to issue licenses to any inhabitant for clam, quahaug, scallop and other shellfish cultivation. It seems strange that such a precocious and beneficial act should have been enacted at such a period, certainly before the time was ripe, as is made evident by its repeal the following year. Only within the past few years has similar legislation been passed for the quahaug, as typified by the act of 1909, which permits granting of leases by the selectmen for quahaug culture provided the town meeting has voted to adopt the general law. The act of 1874, though it applied only to the Narragansett Bay section of Massachusetts, clearly emphasizes the fact that shellfish cultivation is no new project. It was considered of practical importance thirty-five years ago.

In 1875 the town of Winthrop, through special act of the Legislature, required that to gather clams for market residents must have permits, and forbade the taking of clams by any nonresident without a written permit from the selectmen. The price of such permits was left to the discretion of the selectmen, and the fine for violation of the act was not less than $5 nor more than $10, but any inhabitant was allowed to take clams for family use or for bait.

In 1880 the word "clam" appears in a general act of the Commonwealth which delegated to towns and cities their present authority and control of the shellfisheries. Later this act was amended by the Acts of 1889, but the substance remained unchanged, and to-day it differs but slightly.

In 1888 the town of Winthrop was authorized to regulate its shellfisheries by an act similar to that already governing those of Plymouth, Kingston and Duxbury, but differing in that not over 2 acres of unproductive flats could be granted to any one person, and no grant could be situated within 500 feet of high-water mark.

During the same year similar legislation was enacted for the town of Essex which embodied the best features of previous acts, and is here quoted: —

Acts of 1888, Chapter 198.

An Act authorizing the Planting of Clams in and around the Shores of Essex.

*Be it enacted, etc., as follows:*

Section 1. The selectmen of the town of Essex may by writing under their hands grant a license for such a term of years, not exceeding five, as they in their discretion may deem necessary and the public good requires, to any inhabitant of said town, to plant, cultivate and dig clams upon and in any flats and creeks in said town now unproductive thereof, not exceeding two acres to any one person, and not impairing the private rights of any person.

Section 2. Such license shall describe by metes and bounds the flats and creeks so appropriated and shall be recorded by the town clerk before it shall have any force, and the person licensed shall pay to the selectmen for the use of said town two dollars and to the clerk fifty cents.

Section 3. The person so licensed and his heirs and assigns shall for the purposes aforesaid have the exclusive use of the flats and creeks described in the license during the term specified therein, and may in an action of tort recover treble damages of any person, who, without his or their consent digs or takes clams from such flats or creeks during the continuance of the license.

Section 4. Said town of Essex at any legal meeting called for the purpose may make such by-laws, not repugnant to the laws of the commonwealth, as they may from time to time deem expedient to protect and preserve the shellfisheries within said town.

Section 5. Whoever takes any shellfish from within the waters of said town of Essex in violation of the by-laws established by it or of the provisions of this act shall for every offence pay a fine of not less than five or more than ten dollars and costs of prosecution, and one dollar for every bushel of shellfish so taken.

Section 6. This act shall take effect upon its passage. [*Approved April 9, 1888.*

In 1901 it was enacted that the Commissioners of Inland Fisheries and Game (now the Commissioners on Fisheries and Game)

should prohibit the taking of oysters, clams, scallops and quahaugs from tidal waters or flats of any part of the Commonwealth whenever so requested in writing by the State Board of Health, and for such period of time as the latter might determine. The scope and other features of this act are discussed more in detail under the subject of pollution.

In 1905 the Commissioners on Fisheries and Game were empowered to conduct a biological investigation and make report as to the best methods, conditions and localities for clam propagation. The final results of this investigation are embodied in this report.

In 1911 the planting and cultivation of clams and quahaugs was authorized in the town of Barnstable, and in 1915 extended to all Barnstable County by an act which provided that: (1) the license term should be not over five years; (2) the area of grants should be not less than 2 nor over 5 acres; (3) transferable only to a citizen of the town of Barnstable; (4) certain powers should be exerted at the discretion of the selectmen; (5) a public hearing should be required before licenses could be issued by the selectmen; (6) the price of $2 be paid to the selectmen for the license and 50 cents for recording; (7) the exclusive use of flats described in license to be vested in licensee and heirs; (8) after failure to use and occupy a grant for two years after investiture, the grant should revert to the town; (9) on any person using flat, other than licensee, a penalty of not less than $5 and not more than $10, costs of prosecution, and $1 for each bushel of shellfish taken, be imposed for each offence; (10) each town might make by-laws to protect its shellfisheries.

Under chapter 710 of the Acts of 1912 any city or town in Essex County was given the privilege of leasing for ten years at an annual rental of $5 per year from the Commonwealth the right to control and regulate the taking of clams from all the flats within its borders.

Town control of the clam fishery has been exerted chiefly through issuing permits. Of the 69 seacoast towns in this Commonwealth, 25 grant permits to take clams. The town of Plymouth issues an excellent permit, which limits the quantity, sale and size of clams taken, besides requiring a weekly report of the number of bushels dug by each holder.

*Proposed Legislation.* — Numerous special laws and regulations have resulted in a lack of uniform control of the shellfisheries of various coastal towns. The future of the shellfisheries depends

essentially upon legislation which will correct the present inadequacies in our mollusk laws and permit the establishment of prosperous industries on our coast. The Commissioners on Fisheries and Game believe that the present situation can best, and will ultimately, be met by placing the shellfisheries under uniform State control. At present they consider that such a disposition should not be undertaken before the selectmen of the various coastal towns have been given a full opportunity to demonstrate their ability to handle the situation. In order to afford every opportunity it is advisable that uniform laws be enacted, especially in regard to guaranteeing a safer tenure for grants than under the existing conditions. The rights of the riparian owners to the areas suitable for shellfish grants should be eliminated through some form of taking by eminent domain on the part of the State. In the light of our present knowledge the following detailed suggestions are offered to the selectmen for working out a definite and uniform system of town control: —

1. The selectmen of every coast town should be authorized to conduct an accurate survey of all mollusk territory below mean high-water mark and to lease such territory for the cultivation of food and bait mollusks. They shall appoint one or more deputies for the detection and prosecution of any violation of the laws of the Commonwealth relating to the mollusk fisheries.

2. The selectmen may, by writing under their hands, grant a license, for a term not exceeding twenty years, to any inhabitant of the Commonwealth to plant, grow and dig mollusks at all times of the year, or to plant shells for the purpose of catching mollusk seed, upon and in any territory below mean high-water mark in their respective towns, upon such terms and conditions as they may deem proper, not, however, materially obstructing navigable waters.

3. All territory for which a license has been granted as aforesaid shall be designated by suitable bounds, consisting of both stakes and buoys, one each at each of the several corners of every grant, so that its precise situation may be in evidence at high and low tide, and these bounds shall be maintained by the licensee under penalty of forfeiture of the license within seven days after his failure to maintain the proper stakes and buoys. The selectmen shall keep at their office a record of each license, describing by metes and bounds the waters, flats and creeks so appropriated, with a map of its location, and these records shall be open at any time to public inspection.

4. Every licensee shall be required to submit to the selectmen, or to a duly authorized inspector or inspectors appointed by them, an annual report of the total number of bushels of mollusks produced upon the

territory covered by his license, together with the value received for the same, and an estimate of the total number of bushels of specified mollusks produced upon the territory covered by his license, together with the value received for the same, and an estimate of the total number of bushels of specified mollusks at that time growing upon the said territory. This statement shall be duly sworn to before a justice of the peace, and if the total sum shall fall below 50 bushels per acre, or if the selectmen, after due examination, shall find that the sum has fallen below 50 bushels per acre for two consecutive years, unless such condition has been brought about by natural causes, then the license shall be declared forfeited and the grant revert to the Commonwealth.

5. The available territory for the growth and planting of mollusks shall be divided into two classes: the shallow waters near shore, including the flats, creeks, inlets and bays, which shall be allotted to the smaller planters; and the deep or more exposed waters, which shall be leased to individual planters, partnerships or corporations, who shall give suitable guarantee of sufficient capital to develop the same. Not more than one-half of the whole territory of the first class in any town shall be granted, and the remaining half, unless voted to the contrary by the voters of the town in regular town meeting, shall be retained as a public fishery. Due regard for the public fisheries shall be given by the selectmen in granting these licenses.

6. Any citizen of a coast town shall have the first right to any license for the territory within the boundaries of that township over any other inhabitant of the Commonwealth who is not a citizen of that town, and at all times and under all conditions the selectmen shall give due consideration to secure to every worthy citizen a just opportunity to participate in and to benefit from these fishing privileges. Any citizen of the Commonwealth may have the right to receive a license under this act in any coast town where suitable territory remains after the citizens of the town have obtained the licenses for which they have petitioned. Preference in the allotment of new licenses shall be given to the holders of oyster, clam and quahaug grants as held under the present laws. After the system shall have been established every grant shall be leased according to priority of petition for the same. Any vacant territory shall be regularly advertised by the selectmen, and residents of a town may at any time file an application with the commissioners stating their ability and what they desire in mollusk territory, which shall be allotted to them whenever there is vacant ground. These licenses shall be granted only to and held by citizens of Massachusetts, firms composed of Massachusetts citizens and Massachusetts corporations domiciled within this Commonwealth.

7. Any citizen, firm or corporation, qualified as aforesaid, desiring to obtain a license as provided above, shall present to the selectmen of the respective town a written application, setting forth the name and address of the applicant, a reasonably definite description of the desired territory, and shall petition that the application be registered, that the territory be

surveyed, that a plan or map be made, and that a license be granted to the applicant.

8. All licenses shall be for the use and profit of the licensee alone, and shall be absolutely nontransferable by sale, sublease, transfer or private contract of any nature whatever, and if any licensee attempts such procedure the license shall thereupon be forfeited. It shall nevertheless be lawful for any licensee to hire labor or assistance for the working of his grants: *provided*, that such labor shall in no wise impair his title or ownership of the grant or cause it to pass from his control. Two years after the death of a licensee the grant shall revert to the town, unless the widow or children or legal heirs of the licensee continue to plant and grow mollusks. In such cases due allowance shall be made for all improvements. Three years before the expiration of a license the licensee shall be informed whether or not he is entitled to a renewal. At the expiration of a license the previous owner shall be given the preference of renewal.

9. Any person holding a license under these provisions shall pay an annual fee of not less than $1 and not more than $10 per acre, the exact amount to be ascertained and fixed annually according to a just and equable valuation by the selectmen, under penalty of forfeiture of the license if the rental is not paid within six months after it becomes due. The money received from the annual fees shall be expended as far as necessary for the protection and surveying of the grants, and the remainder shall be paid into the town treasury. The mollusks sold from any grant and the equipment connected therewith shall be subject to taxation by the towns in the same way as other taxable property.

10. The selectmen shall give notice of every application for a license by publication once a week for three successive weeks in one or more newspapers published in the county in which the land applied for is located, describing the territory and giving the name and residence of the applicant, and the day, hour and place at which the selectmen will give a public hearing on the application, the last publication to be at least one day before said hearing. The license shall not be granted until after a public hearing as aforesaid in the city or town where the land is situated, due notice of which shall be posted in three or more public places in that city or town at least seven days before the time of said hearing. Upon petition of any person aggrieved by the decision of the selectmen upon any application for a license filed within one week therefrom, the superior court, sitting in equity, may, after such notice as it may deem sufficient, hear all interested parties and annul, alter or affirm the decision.

11. The selectmen may grant a permit in writing to any person to take mollusks from the natural beds or from areas designated as unleased at such times, in such quantities and for such uses as they shall express in their permit; but every inhabitant of a city or town may, without such permit, take mollusks from the public beds therein for the use of his family, not exceeding in any week two bushels, including shells, or any fisherman who is a naturalized citizen of this Commonwealth may take from such

public beds mollusks needed for bait not exceeding at any one time seven bushels, including the shells.

12. Any person to whom is issued a license by the selectmen shall have the number of his license painted in letters at least 2 inches high in a conspicuous place on his boats and buoys.

13. No person shall dig, take or carry away any mollusks or shells between one hour after sunset and one hour before sunrise, by any method whatever, from any waters, flats or creeks.

14. Any person who shall wrongfully make claims to any public mollusk ground, of which he has no lease or title from the State, by erecting bounds or monuments thereon of any description, or otherwise claiming the title to such land, shall for the first offence pay a fine of not less than $50 and not more than $100, and for every subsequent offence pay a fine of not less than $100 and not more than $200.

15. Any person who shall wilfully injure, deface, destroy or remove such marks or bounds as may define any lease or grant or place any mark thereon, or shall tie or fasten any boat or vessel to such stake or buoy, shall be fined $20 for each offence. Every person in addition thereto shall be liable in an action on the case to pay double damages and costs to the person who shall be injured by harming the marks and bounds, stakes or buoys of the said grants injured, removed or destroyed as aforesaid.

16. Whoever works a dredge, oyster tongs or rakes, or any other implement for the taking of mollusks upon any territory officially designated as licensed, or in any way disturbs the growth of the planted mollusks without the consent of the licensee during the continuance of such license, or discharges any substance which may directly or indirectly injure the planted mollusks, shall for the first offence be punished by a fine of not less than $50 and not more than $100, or by imprisonment for not more than thirty days, and for each subsequent offence by a fine of not less than $100 and not more than $200, or by imprisonment for not more than six months, or by both such fine and imprisonment.

17. Any person who shall wilfully break up, damage or injure any bed of mollusks, or any tract of land leased from the Commonwealth for a mollusk bed, by depositing thereon earth, stones or dredging or scoopings, shall be punished by a fine not exceeding $500 and shall forfeit his boat or vessel with her tackle, apparel and furniture, and all the implements used by him in injuring such mollusk bed.

18. Any police constable in view of the commission of any offence against the provisions of this chapter shall arrest the offender without warrant and detain him for prosecution for a period not exceeding twenty-four hours.

19. A licensee who violates any provisions of this chapter relative to the planting and growing of mollusks or the planting of shells shall, in addition to the penalties as provided, forfeit his license.

20. For the purity of all Massachusetts mollusks, no territory in polluted waters shall be granted for the growing of mollusks for market. The

selectmen shall from time to time employ experts to make such examinations as may be deemed necessary by the State Department of Health to ascertain the sanitary conditions of the waters over and adjacent to the mollusk-producing areas and may give written certificates of the sanitary condition. No mollusks shall be taken from areas which are found upon examination to be polluted beyond such standards as may from time to time be determined by the State Department of Health, except that this Department may make special rules and regulations for the legitimate use of mollusks from such polluted areas in such a manner as to safeguard the public health.

## THE INDUSTRY.

From the viewpoint of the fisherman methods of securing and preparing clams for market need no explanation, but to the average reader, possibly unfamiliar with the practical phase, the following pages may be of interest.

### The Fishing Grounds.

As Cape Cod marks the dividing line between a northern and a southern fauna, it also divides the clam flats of Massachusetts into two distinct areas. The same species is found both north and south of Cape Cod, but the natural conditions under which it lives are quite different. In comparing these two areas, several points of difference are noted.

1. The clam areas of the north coast are mostly large flats, while those of the south shore are confined to a narrow shore strip, as Buzzards Bay and the south side of Cape Cod for certain geological reasons do not possess flats but merely beaches.

2. The rise and fall of the tide is much higher on the north shore, thus giving an extent of available flats nearly six times the clam area south of Cape Cod.

3. Clam growth as a rule is much faster on the north shore. This is due to the great amount of tide flow over the river flats of the north shore. Current is the main essential for rapid clam growth, as it transports the food. The average south shore flats possess merely the rise and fall of the tide, and as a rule have not the currents of the north shore rivers.

4. The temperature of the northern waters is several degrees colder than the waters south of Cape Cod, affording a longer season of growth for the southern clam.

The present advantages lie wholly with the north shore district, as through overdigging the less extensive areas of southern Massachusetts have become in most parts commercially barren.

Overdigging has not occurred to the same extent on the north shore, owing to the vast extent of the flats. Nevertheless, many acres at Plymouth, Kingston, Duxbury, and even Gloucester and Essex, have become wholly or partially unproductive. The only important clamming in Massachusetts to-day is found in the towns bordering Ipswich Bay. The south shore and a good part of the north shore furnish but few clams for the market.

In view of restocking the barren areas through cultural methods, the north shore possesses two advantages over the south shore: it has a larger natural supply at present, which will make restocking easier; it has larger areas of flats, which can be made to produce twenty times the normal yield of the south shore flats. Although, compared with the north shore, the clam area of the south shore seems poor, it is above the average when compared with the clam areas of other States south of Massachusetts, and when properly restocked the clam flats of southern Massachusetts should furnish a large annual production.

*The North Shore.* — The clam industry of the north shore, Cape Cod forming the point of division between the two great sections of Massachusetts shore, is distributed in approximately four localities: (1) Ipswich Bay, which produces at the present time the greatest supply in the State; (2) the shore from Gloucester to Boston, including Boston Harbor and its tributaries, where clamming is now restricted by the State Department of Health as a sanitary precaution; (3) the shore from Cohasset to Cape Cod, particularly the harbor of Plymouth, with its extensive flats; (4) the north side of Cape Cod.

(1) *Ipswich Bay.* — This section may certainly be significantly called the "home of the clam." The numerous tributaries entering sheltered Plum Island Sound and the tidal rivers presenting extensive flats of smooth, tenacious sand and mud adapt it peculiarly to the growth of this bivalve and the maintenance of a flourishing industry. Here the clamming centers are situated along the rivers that flow into Ipswich Bay or Plum Island Sound, or in the towns which border on the protected waters of the latter, and embrace a total area of 4,260 acres, 2,825 of which are set with clams, 1,595 affording good clamming, while 1,430 lie unproductive.

The most northerly of these extensive clamming territories is located in the Merrimac River, and includes the town of Salisbury and the city of Newburyport. A single flat of 216 acres

extending along the north bank of the Merrimac for nearly 2 miles comprises all of the productive Salisbury ground. The flats of Newburyport, comprising in all about 1,080 acres, of which some 800 are more or less productive, produce the greatest quantity of clams of any city or town in the Commonwealth, and provide a means of livelihood for about 175 men. Flats are broad, level and continuous in nature, and, though muddy for the greater part, they are fittingly adapted to clam culture.

Of the towns bordering upon Plum Island Sound, where clamming is conducted both on the open flats of the sound and those of the river tributaries, Newbury yielded the smallest quantity of clams, although over 300 acres of flats are available. For the most part these are in Parker River and in Plum Island Sound, and are barren. Possibly 100 acres of sand flats, the usual type in this region, contain a few clams here and there, but they supply no good digging and no consistent effort is extended toward utilization. In Rowley we find conditions not dissimilar, as out of 400 acres of available flats only 20 are really productive of as good clamming as is the case on Rowley Reef Knobs, where was found the vast set described in another part of this report.

Ipswich, second only to Newburyport in production, possesses large areas of flats of varied characteristics; which offer great possibilities of development. The flats situated in Plum Island Sound, Ipswich River and Essex River, with their numerous tributaries, are relatively of small size, diverse in character and scattered over a considerable territory. Four distinct divisions of the clam territory of this town may be made, — Ipswich River, Plum Island, Green's Creek with Roger Island, and Essex River. The available ground here averaged 970 acres, 400 of which furnish good clamming, while 420 contain but few.

Essex, while still ranking as an important clam-producing town, has but imperfectly developed her fine resources, although in the past few years clammers have attempted improvements by planting clams on the barren flats. Of the potential total of 650 acres, hardly 25 acres can be considered unfit for the production of clams. Nevertheless, little more than half the area is at all productive, and of this half less than 150 acres yield the main supply. The productive portions are for the most part scattered along the banks of the Essex River, which furnishes excellent sets of seed clams in many places.

At Gloucester the clam flats lie in the Annisquam and Essex rivers, the former flats being the more productive. While the

present clam fishery here is fairly important, it yields but an inconsiderable portion of the possible revenue from the large area of flats now unproductive. The total of flats now in use approximates 550 acres, only 75 acres of which furnish good clamming, while a scant 100 acres produce few clams and 250 acres lie barren, although qualified to produce if planted.

(2) *Gloucester to Boston.* — The section of the coast between Gloucester and Boston is of little importance commercially in the production of clams. It has not the requisite natural advantages for clamming possessed by the shores of Ipswich Bay, and under present conditions can never become of value. Manchester and Beverly are not able to boast of any such industry, while the flats of Salem Harbor, comprising about 100 acres, annually produce a crop to the value of not more than $200. The only localities in this section made capable by reason of natural facilities for the production of clams, Lynn and Boston harbors, are closed to commercial clammers, owing to the danger to public health because of sewage pollution. Under present conditions it is probable that it will be many years, if ever, before such contamination is eliminated by scientific disposal of city sewage and regulation of manufacturing wastes. For this reason, large areas of flats, which otherwise would naturally be productive, or could be made so, can never be utilized for clam culture. Of the 900 acres lying along the shores of Nahant, Saugus and Lynn, over two-thirds could be made prolific, while it is evident that 3,280 acres out of a total of 6,325 in Boston Harbor could be made of value were it not for the pollution. Outside of the proscribed area in Boston Harbor, the towns of Weymouth, Hingham, Cohasset and Hull provide clams merely for home consumption and for bait.

(3) *Boston to Cape Cod.* — Scituate and Marshfield possess some clam territory in the North River, but the output therefrom is inconsiderable. The great clam region of this section is Plymouth Harbor, with its extensive flats in the towns of Duxbury, Kingston and Plymouth. This territory, 5,700 acres in area, contains only 1,475 acres capable of producing clams, the remainder being covered with mussels and eelgrass. Only about 85 acres are producing clams in natural abundance at present; 1,390 acres have been barren until within the last few years, when various areas have been planted and the first large clam farm of 200 acres started. The clam industry of Plymouth Har-

bor is peculiarly interesting as demonstrating a transition from a state of productive prosperity to its present status, or from a time when the trade name Duxbury represented the acme of perfection in clams to a time when this title has become simply a by-word, for Duxbury clams have not been shipped in quantities to the market for years. Whether this great tidal area can ever be converted into extremely profitable clam ground is a difficult question. However, no adequate reason can be advanced why a fishery at least as flourishing and remunerative as of yore cannot be re-established, and the barren flats in part, at least, utilized.

(4) *North Side of Cape Cod.* — The principal clamming centers of this section are Barnstable Harbor and flats along the Brewster shore, where a fairly large amount of clams is shipped to market in winter. The clams from this section are particularly good in quality and bring a good price, and the flats here are now in process of cultivation under a system of local town grants. These flats resemble those of the Ipswich Bay section, and comprise an area of 400 acres, practically all of which may be made productive, but of which only 20 acres now provide good natural clamming. The area of Brewster flats now productive is variable, but opportunities for culture are present, although most places are more or less exposed to the open waters of Cape Cod Bay. At Orleans, the north side of the Cape, clam flats are found in Nauset Harbor, Town Cove, Pleasant Bay and Cape Cod Bay, where they are of a sandy character, a total of 200 acres, 150 of which may be reclaimed. At Eastham similar conditions prevail, although the main source of supply is Nauset Harbor. At this place the total area is 200 acres, 175 of which can be made productive. Wellfleet possesses extensive flats, but only portions may be made prolific, owing to physical surroundings. Out of a total area of 605 acres only 15 yield clams, in spite of the fact that 250 acres of barren flats may be reclaimed. The clam flats of Truro are confined principally to the Pamet River basin, where there are approximately 50 acres of flats, only 3 of which furnish clams. Owing to their shifting nature hardly 6 out of a possible 400 acres of flats in Provincetown Harbor yield clams.

*The South Shore.* — The clam industry of southern Massachusetts is found along the south side of Cape Cod, Buzzards Bay, Narragansett Bay and the islands of Nantucket and Martha's Vineyard, and is relatively of less importance than is that of the north shore.

(1) *South Side of Cape Cod.* — This section offers little opportunity for clam culture because of the presence of a slight tidal flow. The average clam flats here, except in the case of Chatham, consist of narrow strips along the sides of harbors and tidal streams, and the entire production from this section is inconsiderable.

Chatham, situated at the elbow of Cape Cod, produced a greater quantity of clams than all the rest of the Cape in 1879, but to-day the annual output is much less than that of several other towns in the Cape district. Clam territory is situated in Stage Harbor, Pleasant Bay and at Monomoy Point, and comprises 300 acres, but 60 of which produce clams.

In Harwich some clams are obtainable from the shores of Pleasant Bay, Wychmere Harbor and Herring River.

In Yarmouth and Dennis clam fisheries are now found in Swan Pond River, Mill Creek and Bass River, although in former years considerably greater quantities were present in Barnstable. In Mashpee the shores of Popponesset River afford favorable conditions although little clam-producing territory is available.

(2) *Buzzards Bay.* — The section of Massachusetts bordering the shores of Buzzards Bay supports a flourishing quahaug, oyster and scallop fishery, capable of great development. The clam industry, however, never very extensive, is of very slight significance at present, and can never attain the same degree of importance as the other shellfisheries, owing to the limited area available for clams. That clams grow wherever opportunity permits is evident, for they are found on gravelly stretches or among rocks all along the coast, except in those localities openly exposed to the full force of the sea. But allowing for all possible favorable features, the lack of any considerable territory is a disadvantage that will forever act as a barrier to any expansion. Falmouth and Dartmouth on the east and west sides of Buzzards Bay, respectively, differ materially from the remaining towns of the district in the fact that the characteristic soil of their clam grounds is sand; while the other towns have little in the shape of available territory except gravel stretches along the shores of coves, small areas of mud and the rocky beaches of points and headlands. The yearly output hardly anywhere suffices for the needs of home consumption. Nowhere is any attempt at exportation possible. The business, such as it is, is carried on in an intermittent fashion, chiefly in the summer, but with a small investment of capital. That the combined area of

all the towns of Buzzards Bay does not equal that of a single town in the Cape Ann district is an undeniable truth; but the fact nevertheless remains that an industry far more considerable than exists at present could be supported, and it is truly to the interest of the towns of this region to make the best possible use of their limited advantages.

(3) *The Fall River District* (*Narragansett Bay*). — The section of country bordering on Narragansett Bay and the Rhode Island line comprises a territory remote from the other clam-producing districts of the State and possessing many characteristics not found in any other locality. Six towns of this region enjoy the privileges of a clam industry, situated as they are on the shores of Mount Hope Bay and its tributary streams, the Cole, Lee and Taunton rivers. Beginning with the most westerly and taking them in order, these towns comprise Swansea, Somerset, Dighton, Berkley, Freetown and Fall River. They differ only in extent of resources or development of the industry, while the general nature of the clam flats and the methods employed in carrying on the business are essentially alike for all. The area in this region suitable for clam culture possesses some of the distinguishing features of the typical north shore flats, some of the Buzzards Bay variety and some peculiar to itself. There are scarcely any sand flats, and the prevailing type of soil is mud, as at Newburyport, or gravel, as in Buzzards Bay; while the greater part of the clam supply comes from a large and rather indefinite area, which is not properly tide flat at all, but lies continuously submerged.

The methods employed in carrying on this industry include both wet and dry digging. On the tide flats the clams are dug as elsewhere on the south shore, with hoes or the common digger. Where, however, clams are dug in 2 or 3 feet of water, as is most frequently the case, an ordinary long-handled shovel and wire basket are employed. The soil containing the clams is shoveled into the baskets, and then the clams are sifted out under water.

The towns of this region can never compete with the towns of the Newburyport district in the production of clams for the reason that they have by no means an equal acreage of suitable flats. The Taunton River is also a considerable factor, as its contaminated waters impair the quality of clams grown along its shores. There remains, however, a considerable extent of suitable territory which might yield a large product if rightly

controlled, and this territory, with its inherent possibilities depleted to the verge of exhaustion by unwise and wasteful methods, it is for the interest of the Commonwealth to protect and improve.

Swansea, the most western town of this district, is by far the most favorably located, and has the greatest possibilities in clam production. Situated as it is on the northern shore of Mount Hope Bay, and the majority of the flats in the Cole and Lee rivers, it possesses greater available territory, free from contaminating influences of the Taunton River, than any other town in this region. Here the total area suitable for culture is not far from 150 acres, of which about 20 acres are gravel and the rest practically all mud. Somerset, the next town in order, joins Swansea on the east and extends several miles up the left bank of the Taunton River. Its flats on the south and west, particularly in Lee River, produce some clams, but the industry is practically exhausted. The total clam area comprises about 75 acres. Berkley, on the west bank of the Taunton River opposite Dighton, has clam territory similar both in extent and characteristics to that of Somerset; but little use is made of clams taken here except as bait, as the river water renders them very unsatisfactory as food. Freetown, which joins Berkley to the south near the Fall River line, possesses a number of clam flats, aggregating 25 acres, but very little business is carried on, although conditions are better than in Berkley or Dighton. Dighton has a very limited area of clam flats, which comprises only about 10 acres. Clams extend but little beyond the southern boundary of this town on the Taunton River, and about three-quarters of a mile up the Segregansett River on the west. Fall River has no clam territory on the south, owing to wharves and other adverse conditions. At the more open waters of the north toward Freetown there is a stretch of clam ground covering about 25 acres. Here the foreign element of the city dig clams for food, and some are dug for bait, but as a whole the industry is of little consequence.

(4) *The Islands.* — Although Edgartown possesses 200 acres of potential clam flats, it is not in a true sense a clam-producing town. The nature of its flats, which at low tide are mostly under water, makes clamming difficult, and this fact answers for the limited production. The clam territory of the town is situated along the shores of Cape Poge Pond and in the lower part of Katama Bay, where many acres of flats are continually submerged. The shore flats are small in area, owing to the light

rise and fall of the tide, which is less than 3 feet at this part of the coast.

At present Nantucket does not possess a clam industry of any importance. Years ago it is claimed that clams were abundant there, and that quantities were dug for food and bait, but now the reverse is true, and fishermen often find it difficult to procure clams even for bait. Indeed, the clam fishery of Nantucket is an excellent illustration of decline in clam industry. Practically all its flats are shore flats, *i.e.*, narrow stretches along the shores of the harbor and on the sides of the creeks. Thus the area, though extending for many miles, is not great, and the clam industry of the island, though capable of development, can never assume the importance of its quahaug and scallop fisheries.

## History.

*Early History.* — The early history of the Massachusetts clam industry is buried in obscurity. Even before the time of the earliest settlers the native Indians depended largely upon the abundant mollusk for their food supply, as is clearly indicated by the scattered shell heaps which mark their ancient camp fires. Upon the arrival of the Pilgrims, clam digging was incorporated among the most time-honored industries of the Commonwealth, and in times of want the early colonists depended largely upon this natural food supply. The arrival of the colonists marks the first epoch of the clam fishery as an economic factor in this Commonwealth, a period which lasted nearly two hundred years. This period witnessed the exploitation of the clam grounds merely for home consumption. Money was scarce, inland markets were practically unknown, and the importance of this shellfish was confined merely to local quarters.

*Rise of the Bait Industry.* — Early in the last century a growing demand for clams as bait for the sea fisheries became apparent. Clams had always been utilized for this purpose more or less, but an increased demand called for the development of an important industry in this line. Various centers of activity were established, particularly at Newburyport, Essex, Ipswich, Boston Harbor and Chatham. The clams were mainly shucked, that is, removed from the shell, and shipped either fresh or salted in barrels to the fishermen at Gloucester, Boston and Provincetown. This industry opened up new fields of employment for many men and boys, and brought considerable ready money into various coast communities.

*The Development of Inland Markets.* — The consumption of clams for food in the coast towns continued throughout the rise and gradual decline of the bait industry, but the creation of inland markets did not begin to be an important factor until 1875. It was about this time that the clam came to be generally looked upon throughout the State as an article of food, and consequently an important industry was gradually evolved to meet this growing demand. This step marked the beginning of the extensive fisheries of the present day.

The mistaken policy of the average shellfish community, which regarded clam grounds as natural gardens of inexhaustible fertility, still persisted, even after the fallacy of this policy had long proved apparent through the depletion of extensive tracts. The same ill-advised methods were pursued, to the ultimate ruination of much valuable territory. All wise regard for the future was overshadowed by the immediate needs of the present; local legislation fostered the evil; State legislation was conspicuous by its absence; and, left to the mercy of unsystematic digging, these natural resources rapidly wasted away.

The disastrous tendencies which have lurked in the ruling policy of the clam fishery have been shown in the rise and fall of the industry in certain localities. Forty years ago Duxbury and Plymouth ranked as the greatest clam towns of the coast. Their supply has long since become insignificant. Newburyport and Ipswich have become the chief producers of the State clam harvest; but Essex and Gloucester, in the same fertile regions, have greatly declined, and the industry at Rowley has become nearly extinct. In the Fall River district the digging of small seed clams for food has brought the fishery to the verge of ruin. The few resources of Buzzards Bay have become nearly exhausted, while on Cape Cod the industry has shown here and there a temporary increase, overshadowed by a far more extensive decline, such as at Chatham. Furthermore, the sewage contamination of coast waters in the harbors of Boston and several other large cities has closed extensive regions to the production of food.

*Attempts to develop the Industry.* — Various efforts have been made to restrain overdigging the clam flats, by local regulations, particularly by "close" seasons. These attempts have been productive of little good. Other efforts, designed to develop extensive tracts made barren by wasteful methods of fishing, have been put in operation. These efforts have been along two independent

lines: the first, an effort on the part of the community to seed in common flats by the appropriation of money for that purpose, as in the case of Wellfleet; the second, an attempt to arrive at the same end by leasing private grants to individuals, as at Essex and Plymouth. These efforts, while tending in the right direction, have not as yet yielded the results that might be wished for. Within the past three years the State has taken hold of the problem, and by an extensive series of experiments is endeavoring to devise practical means by developing the great inherent possibilities in this extensive industry.

*Clam Production Table for Massachusetts, obtained from the Reports of the United States Fish Commission.*

| YEAR. | Bushels. | Value. | Price per Bushel (Cents). |
|---|---|---|---|
| 1880, | 158,626 | $76,195 | 41.73 |
| 1887, | 230,659 | 121,202 | 52.54 |
| 1888, | 243,777 | 127,838 | 52.44 |
| 1889, | 240,831 | 137,711 | 57.14 |
| 1892, | 191,923 | 133,529 | 69.57 |
| 1898, | 147,095 | 102,594 | 69.74 |
| 1902, | 227,941 | 157,247 | 68.98 |
| 1905, | 217,519 | 209,545 | 96.19 |

## THE CLAM INDUSTRY.

*Methods of Digging.* — The ordinary method of taking clams is so simple as hardly to need explanation, yet clam digging requires considerable skill, and it takes years of experience to become a good clammer.

There are two methods of clam digging used in Massachusetts, — the "wet" and the "dry" digging. Wet digging is carried on when water is over the clam beds; dry digging, which is the common method, takes place when the flats are left exposed by the tides. The only places in Massachusetts where wet digging is carried on regularly are Eastham, Chatham, Swansea, and in Katama Bay, Edgartown. In the lower end of Katama Bay is found a submerged bed of clams which is one of the most productive beds of this class in Massachusetts. These submerged clams are taken with what is known locally as a "sea horse," which is an enlarged clam hoe, with prongs 12 to 14 inches long,

and a strong wooden handle 4 feet in length. This handle has a belt attachment which is buckled around the clammer. Two men are required for this work. The sea horse is worked deep into the loose sand and is dragged along by one man, who wades in the shallow water over these submerged flats, while his partner follows, gathering the clams which the sea horse roots out. Another method of wet digging is called "churning," and is based on the same principle as the above method, only the clams are turned out under water by long forks or hoes. This method is not used in Massachusetts to any extent. Excellent results are usually obtained from wet digging.

The methods used in dry digging depend upon the nature of the soil. The difference lies only in the kind of digger. The clam hoe of the south shore, where the soil is either coarse sand or gravel, has broad prongs, some even being $1\frac{1}{4}$ inches across. The usual number of prongs is four, but occasionally three broad prongs suffice. The clam hoe of the north shore, often called "hooker," has four thin, sharp prongs and a short handle. The set of this handle is a matter of choice with the individual clammers, some preferring a sharp, acute angle, and others a right angle. This style of clam hoe is best suited for the hard, tenacious clam flats of the north shore. At Essex spading forks are used for clamming, but not as extensively as the hooker. For sand digging the forks are said to be better, while for mud digging the hooker is preferred.

*Outfit of a Clammer.* — The outfit of a clammer does not require much outlay of capital. A skiff or dory, one or two clam hoes and three or four clam baskets complete the list. Occasionally, as at Ipswich, where the clam grounds are widely scattered, power dories are used, and this necessitates the investment of considerable capital; but the investment of the average clammer does not exceed $26. Personal apparel, such as oilskins and boots, are not considered under this head.

*Clamming Outfit.*

| | |
|---|---|
| Skiff dory, | $22 00 |
| Two clam diggers, | 1 50 |
| Four clam baskets, | 2 00 |
| Total, | $25 50 |

The boats most often used by the north shore clammers are called "skiff dories," and in construction are between a dory and a skiff. These boats are especially adapted for use in rivers.

*Marketing.* — Clams are shipped to market either in the shell or "shucked out." Two rules are followed by the clammers in making this distinction: (1) small clams, or "steamers," are shipped in the shell, especially during the summer months, while the large clams are "shucked;" (2) the fine appearing sand clam is usually sold in the shell, while the unprepossessing mud clam is shucked, *i.e.*, the shell and the external covering of the siphon or neck are removed. This causes, on the north shore, a division by locality. The Ipswich and Essex clams, except for a few individual orders, are mostly shipped to market in the shell, while the Annisquam River and Newburyport clams in the winter are usually shucked. Little if any shucking is done by the south shore clammers.

Shucking almost doubles the value, as a bushel of clams, worth in the shell 75 cents, will furnish, when soaked, about 10 quarts of shucked clams, which bring about 50 cents per gallon, or a total of $1.25 when marketed. The shucked clams are put through a process of soaking in the same way the scallop "eyes" are treated before marketing. They absorb a sufficient quantity of fresh water, after soaking six hours, to increase their bulk about one-third, which gives a plump appearance to the clams.

While many clammers do not soak their clams, it seems to be a universal tendency, wherever clams are shucked, to gain by this method. Soaking of any sort impairs the flavor of the clam, and for this reason such a practice is to be deplored, but as long as the consumer is satisfied to take second-rate goods this practice will continue, and it can be stopped only by the united demand of the shellfish dealers.

*Shipment.* — Second-hand flour and sugar barrels are used for the shipment of clams in the shell, while kegs and butter tubs hold the shucked clams. In winter, clams can be shipped inland without perishing; but in hot weather they spoil in a few days unless iced.

*Maine Clams.* — Massachusetts annually consumes many thousand barrels of Maine clams. If the demand of the Boston market were not partially met by the influx of Maine clams, the clam flats of Massachusetts would be subject to a greater drain.

*Market.* — The principal market for the clam industry of Massachusetts is Boston. Gloucester, Newburyport, Salem and Lynn draw part of the clam trade of the north shore, but the greater

portion goes to Boston, whence it is distributed throughout the State. In recent years shipments have been made from the Ipswich Bay region direct to New York, Baltimore and Philadelphia.

*Price.* — The price of clams is fairly constant, varying but little in summer and winter. Naturally, this seems curious, when winter and summer clamming are compared. The production in winter is much smaller than in summer, which is due to (1) fewer clammers, because of the severe work in cold weather; (2) less working days, as the clammer is often unable to dig for weeks, and even months, and also cannot work early or late tides, as in summer. In spite of this diminution of supply, the winter price is practically no higher. This is due to a smaller demand in winter, as well as to the influx of Maine clams at this season. In summer there is an increased demand for clams, caused by the arrival of the summer people at the seashore, when large quantities are used by hotels, cottages, etc. This increase in demand is enough to offset the increase in supply, resulting in a stationary price.

The price varies with the quality of the clams, whether soaked or unsoaked, small or large, good or poor looking shells, and fresh or stale. As stated before, the average price received by the clammer for clams in the shell is 75 cents per bushel; shucked clams, when soaked, 45 to 50 cents per gallon.

## GROWTH.

Growth experiments were conducted with the following objects in view: (1) to ascertain the normal rate of growth; (2) to further develop the lines of experimental work begun by Kellogg and Mead; (3) to determine the length of time consumed in the production of a marketable clam; (4) to find the average length of life; (5) to obtain information of practical value to prospective clam culturists; and (6) to discover methods of reclaiming barren flats.

### Methods of Investigation.

*Experimental Beds.* — In order to satisfactorily solve the problems of clam growth under varied environments it was essential to lay out numerous experimental beds, necessarily of small size, owing to the limited appropriation for this investigation. Three sizes were used, $\frac{1}{100}$, $\frac{1}{1000}$ and $\frac{1}{4000}$ of an acre, $\frac{1}{1000}$ of an acre proving the most convenient. These plots were bounded by

stakes and protected by signs, which briefly stated that the enclosed space was under the control of the Commonwealth for experimental purposes, as provided by chapter 327, Acts of 1906, but in spite of these precautions many of the beds were destroyed by trespassers after the clams had attained adult size. The experimental beds were put out under varied conditions of tide, current and soil, on both barren and productive flats, along the Massachusetts coast.

*Recording.* — Different methods of planting were tried. In many instances the seed clams could be obtained in the immediate locality only with more or less difficulty, so they were transported from a distance. At first they were measured with rule, calipers and a triangular measuring instrument, such as described in the report on the "Scallop Fishery" in 1910. Later, after a table of the number per quart for each length from 10 to 85 millimeters had been made from hundreds of specimens, and a table of corresponding width and thickness for any given length similarly formulated, actual measurement of the clams was discarded in favor of recording the number per quart.

An easy means of recording the successive yearly growths of the planted clams was afforded by notching the edges of the shell with a file, a method originated by Dr. A. D. Mead of the Rhode Island Commission on Inland Fisheries, who states: —

> As it [the clam] grows the notch remains perfectly distinct, and always at the original distance from the hinge. A growth ring usually accompanies the notch, and so, after a month, or even years, the complete outline of the clam at the time of notching can be readily identified and traced upon the shell of larger growth.

*Planting.* — In most beds the seed clams were planted individually, after the bed had been thoroughly cleared of the natural clams. This was accomplished either by making holes in the sand with a finger or sharpened stick, and then dropping in the clam, siphon end up, or by a more elaborate method with a wooden framework divided into square feet. By means of this device it was possible to plant different numbers of clams to the square foot in the same bed, and by using the same framework redig them in the same order. Another method of determining the maximum production per square foot consisted in sinking bottomless wire baskets into the soil, thus confining the clams. In the larger beds the clams were merely scattered evenly over the surface before the tide covered the flat, and under such con-

ditions the small clams, if fresh, burrowed rapidly. Methods of preparing the soil and regulating the time of planting according to tide, current, wind and soil were attempted with varying results. Beds were tried on high and low flats, both between the tide lines and below low-water mark. At Monomoy Point clams were planted in submerged boxes of sand and suspended from a raft, as described in the "Quahaug Report," 1912, and their growth compared with that on the Powder Hole flats.

*Location.* — The experimental beds were located principally in Ipswich Bay and its tributaries, in Plymouth Harbor, and at Monomoy Point, Chatham. In addition a large number were planted n the following towns: —

| | | |
|---|---|---|
| Newburyport. | Kingston. | Falmouth. |
| Newbury. | Plymouth. | Edgartown. |
| Rowley. | Dartmouth. | Nantucket. |
| Ipswich. | Wellfleet. | Bourne. |
| Essex. | Provincetown. | Marion. |
| Gloucester. | Chatham. | |
| Lynn. | Harwich. | |

These beds were placed under all sorts of conditions, favorable and unfavorable, on productive and barren flats, and in some cases were never recovered, having been destroyed by an unfavorable environment or by clammers. The majority were recovered, and the growth of the planted clams under a variety of natural conditions was obtained.

*Ipswich Bay Experiments.* — This section comprises the flats of Plum Island Sound, Ipswich River and Essex River, lying principally in the towns of Ipswich and Essex. Experimental beds were planted in Ipswich River, Plum Island Sound, Greens Creek, Roger Island Creek and Essex River.

The Ipswich River has in itself a great variety of clam ground. Both sides of the river for nearly 3 miles are fringed with flats, mainly of mud, though sandy near the mouth. Some of the mud flats are so soft that they are practically barren, or covered with mussel beds; while certain sand flats, *e.g.*, the main portion of the high sands, are too shifting to be valuable. However, the larger part of these river flats are productive.

The Plum Island division comprises Lufkins, Point Peter, Appletons, Foresides and several other minor flats. Of these, Lufkins is important. It occupies a semicircular depression on the

coast of Plum Island, and, owing to its peculiar location, the swift current which flows past its outer edge makes a double eddy at both ebb and flood tide. The outer border to the north is mud, to the south sand. The portion near shore is a hard bluish clay in which clams are abundant.

Point Peter, or "Pint" Peter, is also an important flat, comprising altogether 28 acres, though about 7 acres of the outer portion are so shifting as to be practically worthless. The remainder varies from sand and hard mud on the outside to soft mud in the creeks. The central portion of the flat is peculiarly adapted to the culture of clams, and is extremely productive.

Appletons Flat comprises about 6 acres of hard, tenacious sand, thickly strewn with old clam shells. It lies at the mouth of Perkins and Pine Creeks, which run for about a mile into the mainland of Plum Island, and which contain nearly 25 acres each of fairly productive flats.

Foresides is a thatch island a little over a mile in length, lying in the mid-channel of Plum Island Sound. The sand flats which surround it on all sides comprise about 80 acres. The western side is more or less productive, though the outer edge, over which the strong cross currents of the channel sweep, is unsuited for clam growth. The strip of sand along the northern and northeastern sides, though of rather limited area, is productive, while most of the southeastern portion, which projects far into the channel, is barren and totally unadapted for the soft-shelled clam, though bedded with sea clams. The productive section of this flat is one of the most important of the Ipswich clam grounds.

The west coast of Plum Island Sound, comprising the Greens Creek and Roger Island Creek territories, extends from the Ipswich River to the Rowley River. This division contains the bulk of the waste and barren flats of Ipswich, although there is exceptionally good clamming in Stacys Creek, Third Creek and the "Nutfield."

In the lower Essex River region the three main flats are Essex Beach, Wheelers and the Spit. Essex Beach usually has a good set, evenly sprinkled over the ridgy, shifting bars that skirt the channel. Wheelers is an irregular sandbar, occupying about 77 acres, one-half of which is productive. The Spit, mainly a sandy soil, lies in the three towns of Ipswich, Essex and Gloucester; about one-third of the whole area of 300 acres lies within the town of Ipswich. This whole bar is so liable to change that any

calculations based on the precise area or location of clam territory are decidedly unreliable. Good digging occurs in limited areas on the north and west sides.

In the region of Conomo Point, numerous flats, a large portion of which are barren, are situated along the sides of Essex River and its tributaries. Many experimental beds were planted in Joe's Creek, on "Newfoundland" and other flats near Conomo Point. "Newfoundland," a barren flat which formerly had been productive, yielded excellent results, owing to its favorable location at a bend in the river. The results of the clam planting on barren flats in this section were most successful, and served as a stimulus for clam farming in Essex.

*Plymouth Experiments.* — During the year 1906 and 1907 experiments were carried on with a view to ultimately increasing the production of the extensive flats of Plymouth Harbor. At that time the prevailing conditions were studied: (1) by a careful observation of the natural clam on the shores and flats; (2) by numerous artificial beds; and (3) by recording the 1906 set.

Plymouth Harbor presents a vast area of flats more or less covered with eelgrass, with a great variety of soils. Three towns, Duxbury, Kingston and Plymouth, share the fishing rights of this harbor. The natural conditions are: (1) large rise and fall of tide; (2) good circulation of water, due to the swift currents, except on the shore flats of the western side; (3) high flats with long exposure; (4) variety of soils, ranging from a shifting sand to a soft mud; (5) great area of eelgrass flats.

In 1906 clams were naturally present in the greatest quantities (1) in the gravelly soil upon the south side of Clarks Island, (2) on Plymouth Beach, and (3) in the grants to property holders along the western shore, where all conditions for the growth of clams, except current, were satisfactory. These shore flats, exposed for many hours, were washed by a gradual inspreading of the water and an equally mild ebb, with the result that the current was not strong enough to permit even an average growth. This area, which included the entire extent of the shore flats from the Cordage Company's plant to Eel River, was small as compared with the possible clam areas of the barren harbor flats, some of which were later placed under artificial cultivation by the Andrew J. Kerr Company.

In 1906 here and there on the uncultivated central flats of the harbor an experienced clammer might be able to dig a few large clams, but in general this mollusk was not found in abundance.

Upon the top of Wind Flat, among beds of mussels, some clams were present. Near at hand were areas swept by a better current but absolutely void of clams, though they appeared similar in every respect to good clam flats in other localities along the coast.

Egoberts, the larger of the two Kingston flats, has an area of about 275 acres, covered by thick eelgrass, except for a triangular piece in the mid-southern section, which comprises about 80 acres of smooth, unshifting sand. The greater part of this open section is barren, although a few clams are scattered along the edge near the channel.

Greys Flat, situated to the west of Egoberts, is of an entirely different type. It is a long flat, with a uniform width of 100 yards, and runs throughout its length parallel to the shore, while on the east side it is separated from Egoberts by a channel. It is essentially different in the nature of its soil, which is mud throughout. Although the total area of the flat is about 115 acres, an irregular section of mud on the southeastern part comprising 30 acres, is the only available clam territory. The flat is composed of soft mud on the north and on the south, but the middle section contains several acres of hard mud.

During the year 1906 a series of experiments in clam culture were conducted at Plymouth, in the course of which approximately 100 small beds were planted, most of which proved unsuccessful. These beds, which averaged but 40 clams each, were situated on the Oyster Grant, Beach Wharf Flat, White Flat, Greys Flat, Egoberts Flat, Corys Flat and near the outlet of Eel River. On examination ten weeks later only 7 per cent. were recovered. The explanation of this lack of success, as compared with the experiments in the Ipswich Bay region, probably lies in the fact that the experiments were located for the most part in unfavorable places where the clams were easily destroyed.

In 1907 further experimental beds were planted on Greys, Egoberts and Whites flats, and upon the shore flats on the grant of Frank J. Cole of North Plymouth, who afforded every assistance in his power to further the work. Thirty-four beds planted with comparatively large seed clams proved more successful on these flats and supplied definite data as to the rate of growth in the northwestern part of Plymouth Harbor, particularly in regard to the influence of soil, eelgrass, drainage and current.

*Monomoy Experiments.* — During the period from 1905 to 1910 growth experiments were conducted in the Powder Hole, a shel-

tered harbor of salt water situated at Monomoy Point, Chatham, at the elbow of Cape Cod. In former years the Powder Hole was a spacious harbor where a hundred vessels could anchor, but the sandbars have so shifted that nothing remains at the present time but an almost enclosed body of water of perhaps 5 acres connected with the ocean on the bay side by a narrow opening through which a dory may enter at high tide. The opening changes constantly, owing to the shifting nature of the sand, and has successively worked from the south to the north side, and closed and reopened again at the south at intervals of one and a half years. A large part of the original harbor is now either dry land or salt marsh, while on the north and west sides is a sand flat of 3 acres, which up to 1910 contained an abundance of soft clams. The harbor itself is slowly diminishing in size, due to the encroachment of the sand, and will doubtless eventually become completely landlocked.

The water on the north and west sides averages from 15 to 18 feet in depth, and gradually shoals to the south and east. In the shallow water the soil is covered with a heavy growth of eelgrass. The rise and fall of the tide is about 1½ feet on the average, but it is extremely erratic, as the force and direction of the wind, and the position of the opening, are important factors in determining the amount of water passing through the narrow inlet. The location and depth of the opening makes it possible for the clam flat to be constantly under water for weeks, while at other times several days may pass when the water barely covers the flats. At such times the water is over the flats for only a brief period, probably not averaging over five hours out of the twenty-four. Naturally, the amount and frequency of the tidal flow affect the salinity of the water, which varies with the influx of the tide. The volume of water also varies with the high or low running tides, as a certain height has to be reached before water will flow through the inlet.

(1) *Box Experiments.* — Two main classes of experiments were undertaken, bed and box, which differ but slightly, the latter a convenient modification of the experimental bed, consisting of small wooden boxes filled with sand and equipped with rope handles. The advantage of the experimental box lay, first, in its greater accuracy, since it permitted the operator to obtain each time the exact number of clams planted, a practical impossibility with the planted bed, and secondly, it furnished a convenient form of handling.

The box experiments were divided into classes as follows: (*a*) boxes in the shallow water near the shore, at a depth of from 1 to 3 feet; and (*b*) boxes suspended by ropes from the raft. In all cases, especially on the raft, they were made as strong as possible to withstand the strain. The boxes could be used only one year, as the ship worms (*Teredo*) render the wood unfit for further service. The shallow-water boxes, which were located on the south side of the Powder Hole on clear bottom, were somewhat larger than the deep-water boxes, as they could be more easily handled.

A raft, 20 feet long by 10 feet wide, was moored in the Powder Hole near the flat on the north side, where the deepest water and the best circulation were obtainable. It was provided with a central well and four trapdoors, by means of which the boxes could be lowered to any depth up to 18 feet. This raft was used only during the summer months, and in the winter was hauled up on land, the box experiments being transferred to water deep enough to avoid the ice.

The natural conditions on the raft were especially favorable for clam growth, and extremely good results were obtained. The position of the raft was such as to receive the full benefit of the incoming tide as it passed over the flat, bringing with it abundant diatomaceous food.

(2) *Experimental Beds.* — The planted beds were located between the tide lines in the different parts of the clam flat. The first of these beds was planted in 1905 and the last taken up in 1910. Important results are obtained by a comparison of growth between the tide lines and in the submerged raft boxes.

## Average Growth.

In the determination of the average growth of the clam it is difficult to make general statements, since the natural conditions which influence development are varied. The rate of growth in one body of water invariably differs from that of other localities, unless similar conditions are present, instances of which occur but rarely in nature, a fact which necessitated the use of a large number of experimental beds. Therefore, the reader should understand that the general figures given in the following pages do not hold absolutely true for individual localities, since they are merely averages for certain sections of the coast.

The enlargement of the shell indicates a proportionate growth of the body, and new shell formation is the direct result of a

previous corresponding growth in the soft parts, which necessitates further extension of the shell. In the growth experiments the shell has been accepted as typifying the development of the body, and all measurements have been recorded on this basis. In another section the quality of the meat and the plumpness of the tissues, so important to the dealer, have been considered.

The shell of the clam, as of all mollusks, is almost wholly composed of lime salts obtained from the water, but the amount of soluble lime in the water, although an important factor in the rapidity of growth, is not as essential as is the proper nourishment of the soft parts by the ingestion of microscopic food forms. Actual increase in growth due to an excess of lime is but slight, since shell formation naturally is correlative to the increase in the soft parts. The difference in localities rich in lime salts is evidenced only by an increased weight of shell. The lime supply varies slightly in different localities, but its efficiency is dependent largely upon the circulation of water. However, food is most vitally important. Within limits, the growth of the clam is directly proportional to the amount of food it consumes. This food consists primarily of microscopic plant forms, called diatoms, which are uniformly distributed throughout the water. Naturally the abundance of diatoms in any locality and the circulation of water, the current, are the two important factors in the growth of the clam.

*Length of Life.* — The maximum period of life for the clam is difficult to determine. To our knowledge one of the largest shells ever found in Massachusetts was found on Greys Flat, Kingston, and measured 5¾ inches in length. At one point where the flat had been worn away by erosion, the ground was white with thousands of these large shells in an upright position, indicating that destruction had suddenly come upon them. The age of these clams could have been no less than twelve years. Naturally the size does not signify the age, as the rate of growth varies with the location. A clam high up in the sedge, near high-water mark, may be small in size but at the same time several years older than a large clam more favorably situated. The age of the clam may be estimated from the weight of the shell, the frequency of growth lines and the signs of external wear, especially on the umbones. Under natural conditions, when clams are not dug for market death may result from destructive washouts

**Yield in Two Years from an Experimental Clam Bed.** — Note the amount of clams planted, compared with the marketable clams taken out. The size of the bed was 1/100 of an acre. The clams had increased in size so that 8 quarts were obtained for every quart planted. This shows what could be done with many barren flats if individuals had the privilege of cultivating clam farms.

in heavy storms, prolonged exposure in hot weather and disease when thickly set.

*Average Rate of Growth.* — The average growth for the entire coast in terms of a 25-millimeter clam is 38 millimeters, or a gain of 1,635 per cent. in volume. In general, clams from river flats, where the current is strong, show a faster growth than shore clams, owing to the better circulation of water. At Monomoy for several years the annual growth in raft boxes, shore boxes and on the flat was compared. The raft and shore boxes were submerged continually, the raft having a better current than the shore. Naturally the best growth was found in the raft boxes.

*Growth for the Market.* — Mead (13–16) says that a clam may grow to marketable size in one and one-half to two years, a statement which coincides with the results obtained in certain Massachusetts experiments, where, by planting clams 1 inch and over under favorable conditions, marketable clams were produced in *one year*. The definition of a marketable clam varies with locality, abundance, and whether it is to be served as a "steamer" or "shucked." However, it is fair to consider that a clam of 2½ inches is marketable, and on good growing flats this size may be obtained in two years' time.

Diversity in growth may be said to be due mainly to location with respect to three essential conditions, — current, length of time submerged and soil, — and even the results stated here cannot be applied to every locality, since each flat has, as it were, an individuality all its own. The following statement gives briefly the general results obtained with numerous experimental beds under a variety of conditions. For the sake of simplicity, a 1-inch clam is taken as the standard.

A 1-inch clam will grow in one year to a size between 2 and 3 inches. Under favorable conditions, with a moderately strong current, the average will increase to 2½ inches, a gain of 1,600 per cent. in volume, which means that for every bushel planted the yield in one year would be 16 bushels. In the case of beds with but little current, 1-inch clams average about 2 inches in size in a year, a gain of 865 per cent., or a return of 8.7 bushels for each 1 planted. Certain beds under exceptionally fine conditions have shown the amazing rate of 30 bushels for every bushel of 1-inch clams planted. In these beds clams increased from 1 to 3 inches in length.

*The Maximum Production per Square Foot.* — The number of clams per square foot that can be raised to best advantage depends primarily upon the location of the flat with regard to natural conditions. Clams thickly planted in favorable locations may show a greater growth than when thinly planted in less favorable habitat; therefore, no definite statement can be made which will apply generally. It can only be stated that a flat with a current will produce a greater number of clams per square foot than one without, and on good flats they may be planted conveniently and economically from 15 to 20 per square foot, or even in larger numbers. Experimental determination of the maximum production per square foot is difficult, for unless the experiment covers a large area, slight influences of environment affect results. Attempts were made to ascertain the maximum production by means of sinking into the soil bottomless wire baskets, each enclosing one square foot of surface, in which various numbers of clams were planted. Experiment No. 80 at Monomoy Point comprised a series of twelve baskets, containing from 3 to 49 clams per square foot, which were planted on Oct. 30, 1905, and taken up May 13, 1907. The growth did not materially differ between the 3 and the 49 per square foot beds, as can be seen from the following table: —

| Number planted. | Number found. | Per Cent. lost. | Length Gain (Millimeters). |
|---|---|---|---|
| 3, | 1 | 67 | 26.00 |
| 5, | 4 | 20 | 29.50 |
| 8, | 8 | - | 27.25 |
| 10, | 5 | 50 | 23.40 |
| 12, | 8 | 33 | 30.25 |
| 16, | 15 | 17 | 30.47 |
| 20, | 13 | 35 | 28.23 |
| 30, | 22 | 27 | 29.54 |
| 35, | 18 | 49 | 26.89 |
| 42, | 35 | 17 | 28.63 |
| 49, | 28 | 43 | 27.14 |

It is readily conceivable that if a bed has a poor circulation of water overpopulation may result in an insufficient food supply and slower growth. Dwarfed forms caused by crowding should be differentiated from those caused by lack of growth because of

a naturally insufficient food supply. The number per square foot which will give the best growth in a given locality can be determined only by the planter's gradually increasing his stock until the maximum production is reached.

*Growing Months.* — The clam differs slightly from the scallop, quahaug and oyster in that its growing season, as typified by shell formation, is longer. Growth takes place at a lower temperature than with the quahaug, which increases its size only during the warm summer months, from May 1 to November 1. This peculiarity is readily explained by the fact that the clam is a colder water species, its range extending from New Jersey north on the Atlantic coast. The clam has a definite winter growth between November 1 and May 1, which, however, is but a small proportion of the annual increase. Undoubtedly the greater portion of the so-called winter growth takes place during November and April. Decrease in the microscopic food forms in the water is not sufficient to explain the cessation of growth, which is also due to the inactivity of the clam during the cold weather in assimilating food and lime salts. Evidently the clam is capable of performing its nutritive functions at a lower temperature than the quahaug, scallop and oyster, possibly ceasing at a point between 40 degrees and 42 degrees F.

An interesting comparison was made between clam beds in the Essex River, in Plymouth Harbor and on the south side of Cape Cod. In Essex River very slight growth occurred between November 1 and May 1, as was readily demonstrated by a notch filed into the edge of the shell. In Plymouth Harbor the beds, especially upon the mud flats, showed a growth of several millimeters during this period. South of Cape Cod, particularly at Monomoy Point, there was an appreciable growth during the winter months. This peculiarity can best be explained as due to difference in the temperature, exposure and current.

*Summer and Winter Growth on Sand and Mud Flats.* — By a comparison of clam growth at Plymouth in mud (Wind Flat) with that in sand (Whites Flat), interesting observations were made regarding the proportionate increases in winter and summer.

Growth for nine and two-thirds months proved slightly more rapid in the mud bed, and was especially marked for the seven and one-third cold months, whereas almost the reverse proved true during the two and one-third warm months of this period. The mud flat, rich in organic matter and clam food, such as dia-

toms, gave a faster winter growth than did the sand flat, with less food on its surface. Diatoms are more numerous and multiply more rapidly on muddy soil, which holds the warmth of the sun, and therefore more food is close at hand for the clams during the winter. In summer diatoms are equally distributed throughout the water, and since clams obtain their nourishment from the water, growth is faster on the sand flat, where there is no clogging of the gills with fine silt.

*Gain in Length in Millimeters.*

| | Oct. 27, 1906, to Aug. 16, 1907 (Nine and Two-thirds Months). | Oct. 27, 1906, to June 6, 1907 (Seven and One-third Months). | June 6, 1907, to Aug. 16, 1907 (Two and One-third Months). |
|---|---|---|---|
| Mud (Wind Flat bed), . . . . . . . | 20.84 | 12.72 | 8.12 |
| Sand (Whites Flat bed), . . . . . . | 16.72 | 7.78 | 8.94 |
| Gain or loss, . . . . . . . . . . | 4.12 | 4.94 | .82 |

*Growth of Old and Young.* — Actual increase in length as well as relative increase in volume constantly diminish as the clam increases in size. In other words, the older and larger a clam becomes, the more slowly it grows. By planting clams of different sizes in the same beds a comparison of the gain in length may be determined. Naturally a small clam, for the purpose of comparison we will say one 20 millimeters in length (the exact size has not been determined), shows the greatest gain. Above that size the yearly gain in length steadily diminishes with advancing age. Under average conditions if a 20-millimeter clam had an annual increase of 28 millimeters, larger clams would show the following growth: a 25-millimeter clam would gain 25 millimeters; a 50-millimeter clam would gain 12.5 millimeters; a 75-millimeter clam would gain 5.8 millimeters; a 90-millimeter clam would gain 4.3 millimeters.

Opportunity was afforded to observe the rate of growth of young clams collected in spat boxes at Monomoy Point. In 1907 boxes containing sand were suspended from a raft in the Powder Hole on June 15 and July 26, and were taken up on October 15. Three hundred and ninety-one clams in the June boxes averaged 34.38 millimeters in length, and 1,637 in the July boxes averaged 32.91 millimeters, or 221.3 per quart. The set which occurred about July 1 showed a difference of 1.47 millimeters in growth

between the June and July boxes. In shallow boxes 1,705 clams averaged 28.72 millimeters, or 361 per quart.

The averages would indicate that when a set is favorably located and continually under water, the growth from July 1 to October 15, three and one-half months, is approximately 30.5 millimeters ($1\frac{1}{4}$ inches). Considerable variations are to be expected in other environments and under other conditions, but these figures express the growth under very favorable circumstances for the first three and one-half months. Naturally, when sets are too thick, as on Rowley Reef, growth is slower, especially if the set is late in the season. The spawning season extends over a period of several months, and if a set does not occur until late in August, cold weather will not permit rapid growth; *e.g.*, on November 13 the Rowley Reef set averaged but 12.9 millimeters (about $\frac{1}{2}$ inch). Feeble winter growth and late set explain the presence of very small clams in the early spring.

*Comparison with Quahaugs and Scallops.* — Arranging mollusks in order of rapidity of growth, — scallop, clam, quahaug, — we find the same order in respect to weight of shell. Therefore we can formulate the general rule that the growth of any mollusk is directly in proportion to the weight of the shell, which not only holds true for different species, but even for the different varieties of clams, as is seen by a comparison of the slow-growing, thick-shelled clams of gravel beaches with the fast, paper-shelled clams of the sandy flats. During the spawning season the clam shows no retardation of growth such as is manifest in the scallop.

The annual growth of a scallop 25 millimeters in size represents a gain in volume of 1,850 per cent.; that of a 25-millimeter clam a gain in volume of 900 per cent. In the case of a quahaug of 25 millimeters there is an increase in volume of 527 per cent.

*Individual Variation.* — Individual variation of clams with regard to growth is frequently found. Certain specimens seem to exhibit consistently slower growth, either from unfavorable position or from impaired feeding powers. In case of defective nutrition, shell formation is slow for a number of years, if not for the entire life of the animal, as in experiment No. 80, when a clam 65 millimeters in size showed a gain of 4 millimeters for one and one-half years, as compared with the average gain of 13 millimeters for clams of similar size under the same conditions.

*Malformations.* — Every time a clam is disturbed in its burrow there occurs a more or less pronounced growth line, which

is due to a slight check in its shell formation. Any injury to the shell which the clam is able to survive results in a greater or less deformity, therefore deformed clams are constantly to be found in natural flats, particularly in gravel and stony soils.

*Transplanting.* — At first transplanting retards the rate of growth of the clam, since a variable length of time is required before it becomes accustomed to its new environment. For this reason, in planted beds the first month's growth is naturally less than the growth in subsequent months, and due allowance should be made in computing the results of short-time growth in any locality. Clams in certain beds scarcely show any change when transplanted, while others apparently take some time to adapt themselves to new environments. Such factors as date of planting, length of time out of water and changes in natural conditions determine this period.

*"Cultivation" of Clams.* — From the mistaken theory that the principles of vegetable cultivation should be applied to clams, the idea has been fostered among the fishermen that the continual overturning of a flat by digging is beneficial for growth. The fallacy of this idea is apparent when one considers that clams are unlike vegetables, which obtain the greater portion of their sustenance from the soil. Except where clams are too thickly set to grow well, *e.g.*, where there are too many mouths to feed, digging is not only of no use but is injurious. In case of a heavy set, it is good policy, by reducing the numbers, to aid nature in her work of establishing an equilibrium, since only a limited number to the square foot of surface can grow to the best advantage.

To determine the actual value of "cultivation" an experiment was carried on in 1906 at Monomoy Point. Two small beds, $\frac{1}{1000}$ of an acre in area, were located side by side near the southern edge of the Powder Hole clam flat. The soil, a coarse sand, was carefully dug over on July 17, 1906, and 1,500 clams from 48 to 58 millimeters in size were removed, showing that the area was productive ground. Owing to a slight current and long exposure, growth in this locality proved slow. Various sizes were planted ranging from 44 to 75 millimeters, an equal number in each bed. One bed was dug over with a clam hoe, without removing any clams, on the first of August, September and October, while the other was left undisturbed. On Nov. 25, 1906, both were taken up, 5.94 quarts of clams being obtained from the undisturbed plot and 3.56 quarts from that which had been

The effect of "cultivation." The larger heap was taken from an undisturbed bed, the smaller from one "cultivated" by digging, but no clams removed. The two beds were of the same size and contained the same number of planted clams.

dug over. A marked difference in favor of the undisturbed bed was found both in the size and number of clams. No difference was noticeable with regard to the catching of 1906 set in the two areas.

| | Dug. | | | Undug. | | |
|---|---|---|---|---|---|---|
| | Number. | Size (Millimeters). | Number per Quart. | Number. | Size (Millimeters). | Number per Quart. |
| July 17, 1906, . . . . | 372 | 52.7 | 58.00 | 372 | 52.9 | 58.00 |
| Nov. 25, 1906, . . . . | 150 | 58.7 | 42.17 | 240 | 59.5 | 40.38 |

## Conditions regulating the Growth of the Clam.

In tidal waters clams are present in abundance on some flats, in scattering quantities on others, and in many sections are entirely absent. A superficial observer may notice but little difference in these areas; but certain definite conditions are essential for the existence of the clam, and there is no more convincing illustration of the influence of environment than its effect upon the rate of growth. Among the surrounding natural forces may be enumerated current, tide, soil, depth and salinity of water, arranged in order of their relative importance, yet so closely interwoven that their separate action cannot always be clearly demonstrated. Any discussion of the conditions which form a favorable or unfavorable environment involves their separate treatment, but the reader should realize that there are few, if any, instances where the pure uncomplicated action of a single natural condition can be obtained. These factors naturally fall into three main groups: (1) the circulation of the water or the current; (2) the condition of the water; and (3) the character of the soil.

### *Current.*

The most important factor in clam growth is a good current, not necessarily an exceedingly swift one, but rather a fair circulation of water. The varied services of the current render it of particular importance to the culturist in the selection of a grant since productive capacity of a clam flat is dependent almost wholly upon the circulation of water. In choice of a location the clam planter may follow the general rule that, as long as the flow of water does not affect his clams in other ways, the swifter cur-

rent gives the faster growth; yet it should be remembered that it has disadvantages as well as advantages, and that no hard and fast rule can be made.

In general, current affects both the life and growth of the clam, but it is difficult to draw a sharp line of distinction, as any effect on growth directly or indirectly influences life. Under the former may be grouped sanitary service, effect on soil and usefulness in determining set. Under the latter may be classed the regulation of food, lime salts and oxygen.

*Food Carrier.* — The current plays a most important part as food carrier. The clam obtains its nourishment from microscopic forms in the water, principally diatoms. These tiny organisms vary extremely in size and shape, and are readily recognized by their silicious cases and beautiful markings, which have won for them the name of "the jewels of the plant world." While diatoms constitute a large proportion of the food of the clam, other forms, such as small unicellular and multicellular animals, bacteria algæ, and possibly soluble proteids are not negligible.

Diatoms are distributed throughout all waters. Different localities vary in abundance according to whether conditions are favorable for their reproduction. Brackish waters are especially prolific in food forms, since there is a mingling not only of the salt and fresh water forms but also of animals and plants peculiar only to brackish water. For this reason small bays, rivers and inlets, to which entering streams carry down from the land the nitrogenous salts, which form a source of nourishment for the diatoms, are favorable localities for clam growth; likewise, the high temperature of water in certain localities furnishes a favorable condition for the reproduction of diatoms.

As with lower animals the growth of the clam is directly proportional to the amount of food consumed, and an animal situated in a current naturally receives a greater supply than one in still water. For all practical purposes current means food, and to a certain extent an increase in current indicates an increase in the amount of available food. Diatoms are of two kinds, pelagic and stalked, the first of which float free in the water, while the second, unless detached, are fastened to the soil. The clam draws from a limited area around its siphon, and when aided by the action of the wind and waves, which dislodge stationary forms, it can feed upon both kinds. Since it is a stationary animal, with limited feeding range, it is obvious that a point of maximum food assimilation can be obtained

where the clam is unable to take in any more food no matter how swift the current. For this reason the term current, as used here, implies only a good circulation of water and not an exceedingly swift flow.

*Oxygen Bearer.* — For years it has been a well-known observation that clam growth is more rapid where water is constantly in circulation than is the case in still water. It has commonly been considered that difference in rate of growth was due to increased amount of food, the clam in the current being most bounteously supplied; but rapid growth from good circulation is a more complex problem than simple increase in available food supply. Five factors determine the amount of food consumed by a clam: (*a*) the amount of food brought by the current; (*b*) the quantity of oxygen absorbed from the water; (*c*) the time of feeding as regulated by exposure of the tidal flat; (*d*) the freedom of the water from contamination or silt, which interfere with the automatic feeding of the clam; and (*e*) the action of wind and waves upon the surface of the flat.

The relation of the first three factors is quite intricate, and the exact proportion that each contributes to the increase in growth is somewhat problematical as far as figures are concerned. Current brings both increased food and oxygen to the animal, as well as serving as a stimulus to its feeding. Oxygen, perhaps, plays a greater part in growth than actual amount of food consumed, since it is necessary for body metabolism and for stimulating the feeding activities of the clam. An experiment was made at Monomoy Point in 1907 to determine the relation between assimilation of food and rate of growth of quahaugs in still and swiftly flowing water, the results of which are equally applicable to the clam. In this connection actual increase in food forms by means of the circulation of the water was alone considered.

Small nets of silk bolting cloth (No. 11) 2 inches in diameter and 4 inches long were so arranged as to rotate on a steel rod like a weather vane. Two nets, identical in every respect, were used, one of which was placed 6 inches below the surface of the water over a quahaug bed, in still water which was 2 feet deep at low tide; the other was placed 2½ feet below the surface of the water over quahaugs bedded in sand boxes suspended from a raft in a good circulation of water. These nets remained extended in the water, and on the slightest provocation would swing on a pivot, so that their openings always faced the cur-

rent. After having been down a certain number of hours they were taken up and the food which had been collected was washed into 15 cubic centimeters of water and counted in the Rafter cell. The approximate number of standard units in each case was determined. Three parallel sets were made, ranging from eight to eighteen hours in duration.

The total number of standard units present in the current per cubic centimeter was 2,188,800; in still water, 1,612,800, giving a gain of 35.7 per cent. in favor of the current. The annual growth of quahaugs in the current showed a gain of 24.5 millimeters, or 612 per cent. in volume, as compared with a gain of 13.62 millimeters, or 241 per cent., in the still water, less than two-fifths as much. It is apparent that the 35.7 per cent. gain in food supply cannot account for the much greater difference in growth, which is due undoubtedly to increased quantity of oxygen furnished by the current, its utilization in body metabolism and stimulation of feeding apparatus of the animal, since other factors, such as silt and wave action, were absent in this case. These figures at best are only approximate, but are sufficient to illustrate that there is a great discrepancy in deduction based solely upon the actual increase in the quantity of food forms and the rate of growth. Therefore we may safely conclude that the other important factor, oxygen, may be of even greater import to the clam.

Oxygen increases the growth in two ways, (1) by increasing the metabolic functions of the clam and (2) by stimulation of its feeding proclivities, but so closely are they connected that it is impossible to determine their relative values. Oxygen is necessary to the life and feeding of the clam since with increased amount of available oxygen bodily functions are performed more readily. Observations upon clams in an aquarium, in still or even stagnant water, showed that such specimens feed but a small portion of the time. For the most part they lay in a semi-dormant condition, with siphons partly extended, but not feeding. When the water was agitated by blowing upon the surface the clams soon extended their siphons and began to feed actively, showing that their feeding activity depends to a great extent upon circulation of the water. This fact explains why practically no growth is evident in clams kept in still-water aquaria.

*Lime Furnisher.* — Similarly, current furnishes the clam with a solution of lime salts, which are utilized in building its shell, a process most essential to growth. An intimate relation exists

between the amount of ingested food and lime, the absorption of the one depending upon the assimilation of the other. The shell increases in proportion to the growth of the soft parts, and unless the supply of lime salts is sufficient, growth is retarded. The lime salts are obtained from the water (this can be demonstrated by growing clams out of the sand), and are probably transformed through bodily activity into suitable form for shell secretion. The amount of lime in solution varies in different localities, but this variation is largely obviated by the current. Water deficient in lime salts but having a good current will produce a better shell than still water rich in minerals, although in localities of rapid growth, where lime is scarce the shell is likely to be thin and fragile.

The importance of temperature in shell formation should not be overlooked. Practically all shell formation takes place during the summer months, growth nearly ceasing during winter. Although the food supply is not correspondingly diminished, cold water renders the animal torpid, and inhibits its activities in feeding and shell secretion. For this reason little growth takes place during the winter, as temperature is the controlling factor in the regulation of growth rate and shell formation.

*Sanitary Agent.* — The work of the current as a sanitary agent consists in carrying away products of decomposition and thus preventing contamination in thickly planted beds. More clams to the square foot may be planted in a current than in still water, where the decay of a few specimens affects others in the same bed. Similarly, current prevents the spread of disease, instances having been noted where whole beds of thickly set clams have apparently perished, although at present little is known concerning the diseases attacking the clam. Current also sweeps from the surface of a flat any deposits of silt, and dead eelgrass or organic matter, thus affording a sanitary environment for the clam.

*Influence on Set.* — The influence of current on the set of young clams has been described in a previous portion of this report. The set is due to the relation of tidal currents to shore formation, inasmuch as larva-bearing streams are deflected by projecting shores and small clams are deposited mechanically to the sides of the current or in the slack water of the eddies.

*Action on the Flat.* — Current affects the existence of the clam by disturbing the surface of the flat and thus interfering with its feeding. If a current is too strong it causes a shifting which

may prevent set and even destroy adult clams. For this reason too swift a current is unfavorable for clam culture.

*Summary.* — Current possesses many advantages, as in the rôle of food carrier, oxygen bearer, lime furnisher, sanitary agent and set producer; but it also has the disadvantage of possible excessive action, causing shifting flats, destruction of clams and prevention of set. Nevertheless, by wise selection of his grant, a culturist may avoid these disadvantages.

### *Water.*

Materials present in water, organic and inorganic, soluble and insoluble, regulate to some extent the growth of the clam. The soluble constituents, comprising nitrogenous salts for the growth of the food forms (diatoms) and lime salts for shell formation, indirectly affect rapidity of growth. The insoluble material, such as silt and sediment, tends to interfere with the feeding of the clam, which mechanically throws off an excess of food and silt by means of its gills, thus instituting an unconscious "hunger strike." On the other hand, the insoluble food forms furnish practically all the nourishment. In addition, the physical characteristics of the water, such as salinity, temperature, depth and tide, influence growth.

*Salinity.* — Clams will grow in practically all degrees of salinity. Experimental beds have been successfully planted in waters ranging from 1.004 to 1.024, and clams from the natural flats between these two extremes have shown little difference in growth. Clams situated in rivers where there is a great rise and fall of the tide frequently have changes from 10 to 15 points in salinity within six hours, and yet suffer no ill effects. It is of interest to the culturist to note that clams can be transplanted from waters of low density to high, or *vice versa*, without apparent harm, an illustration of their hardihood as compared with the oyster, which is affected by slight changes in salinity.

*Temperature.* — The temperature of the water is the underlying factor which regulates the growth, habits and existence of marine animals. It differentiates a tropical fauna and flora from a temperate, and in a more limited way separates the animals of one locality from another.

Its effect upon the spawning season and upon food production, particularly in tide pools, has already been mentioned. Temperature changes explain the fast summer and slow winter

growth, in that the clam's activities in the assimilation of food and in the secretion of shell are stimulated by warm water, while the action of cold water causes the clam to become sluggish. High temperature is of more importance in shell formation than high salinity, as the activity of the animal rather than the amount of salts in the water is the controlling factor.

*Depth.* — Little difference in growth was found at various depths, as observed in boxes suspended from a raft at Monomoy Point. The relation of depth to growth could not be determined on a large scale owing to the impossibility of recovering clams planted in deep water. In all probability the height of water over the flat is of little consequence, provided that there is a uniform distribution of food. In many instances the deeper layers of water in enclosed bays do not exhibit the same circulation as in shallow waters disturbed by wind and wave action; but in tidal rivers the deeper waters may have a stronger current. Since the habitat of the clam is between tide lines, the question of depth is of minor importance.

*Tide.* — Although the natural home of the clam is between high and low water mark, beds are frequently found below extreme low-water mark. Submerged beds have been reported by Kellogg (4) at the Salt Ponds at Woods Hole and West Falmouth in Massachusetts; Kickemuit River, Wickford, and Salt Pond, Point Judith, in Rhode Island; at Sag Harbor, Long Island. Other places in Massachusetts are the Merrimac River at Newburyport, Katama Bay, Edgartown, and Swansea. The difference in growth in beds continually submerged and those between the tide lines has been demonstrated by both Kellogg and Mead, as well as by our experiments in Massachusetts, proving that the faster growth of submerged clams is due to a longer feeding period.

Mead and Barnes (16) give interesting figures comparing growth between tide lines and below low-water mark in two sets of experimental boxes using similar sized clams. The boxes below low-water mark, suspended from the house boat, gave the following figures: July 7, 6.1 millimeters; August 4, 21.8 millimeters, and September 30, 29 millimeters, as contrasted with the boxes between the tide lines, which gave July 7, 6.1 millimeters; 13.9 millimeters August 4, and 23.7 millimeters September 30. Kellogg (6) gives figures on the growth of the quahaug in a series running from high to low water, which exhibit an increase in growth of 145, 154 and 172 per cent., respectively,

as low-water mark is approached. Our experiments with both the quahaug and the clam have substantiated these results, which clearly indicate a lessened feeding period. Assuming that the clam feeds continually when under water, an increased exposure daily materially lessens the amount of food consumed. This assumption is open to the criticism that lower beds have a better circulation of water and therefore a faster growth, but this objection was eliminated by parallel experiments in the raft boxes and on the flat at Monomoy Point, where the only difference was exposure. Clams in the raft boxes gave a greater annual gain in length than flat clams a few feet away.

### *Soil.*

Soil is a less important factor in clam growth than is commonly supposed, and is by no means as valuable an asset to the culturist as current. Soil affects the growth of the clam in two ways, directly by affording a resting place for the clam, and indirectly by regulating the quantity of food. The soil, which furnishes a breeding ground for microscopic food forms, varies greatly in productive capacity and thus indirectly affects the growth of the clam. The action of waves and wind causes the stationary and motile food forms upon the surface of the soil to be washed off into the water, where they are available for the clam. The direct action of the soil upon the growth of the clam, on the other hand, is largely mechanical and depends upon the composition of various constituents of the flat. Soils may be placed in two groups, those below low-water mark and those between tide lines. Clams live in both places but the numbers below low-water mark are relatively small compared with the greater quantity between the tide lines, and for that reason only the latter class, the tidal flats, will be considered.

Kellogg (4) states that a tenacious sand (fine sand mixed with a little cementing mud) furnishes the best medium for growth. Clams will live in nearly every kind of soil provided it is not shifting sand or soft mud. Even in such instances exceptions are frequently found, clams often being present where there is a moderate shift or where the flat is not unduly exposed to storms, and large clams are occasionally found in extremely soft mud. However, to insure best growth soil should be free from decaying organic matter such as is frequently present in soft mud. The soil should be of a firm consistency, not readily affected by storms and currents, and free from substances injurious to the

clam. Any soil possessing these qualifications, regardless of the exact nature of its composition, is suitable for clam growth.

Our classification of soils, after the method of the geological survey, was made on a purely mechanical basis by measuring the grains under the microscope and grouping soils according to the size of the particles. By this table soils were classified into three main divisions, sand, mud and gravel, with many intervening combinations. The actual areas of the different kinds of flats in Massachusetts is approximately 6,269 acres of sand flats, 7,111 of mud, 2,125 of gravel, and 5,580 of eelgrass and mussels, forming a total of 21,085 acres, of which 1,878 afford good clamming and 3,233 scattered clams.

*Sand.* — There are two classes of sand, fine and coarse, the former including a tenacious mixture of mud and sand, and the latter almost fine gravel. Except for the fine particles which cement together the larger grains sand flats are usually free of sediment. The flats of fine sand in the Ipswich Bay region are swept by river currents, and at times approach in character the rippled shifting sands of the exposed beaches. The coarse sand flats of the south side of Cape Cod, which are under the influence only of the rise and fall of the tide, frequently are covered with a crust of algæ and diatoms which afford stability and protection against shifting. The clammers in these sections use two different types of clam hoe; for the fine, compact sand in the Ipswich Bay section a thin-pronged hoe is used; in the coarse sands of southern Massachusetts, one which is broad-pronged is employed. The thin-pronged digger is useless in coarse sand as it slips through the loosely packed grains, while in the compact sand a broad-pronged digger necessitates superfluous labor. The type of shell in sand flats is smooth and homogeneous as contrasted with the rough gravel or mud clam, and the color is white.

*Mud.* — In the case of mud flats we find a greater diversification of class, ranging from compact clay on one hand to coarse, soft mud on the other, and of variable composition. This type of flat is usually situated where there is little current or where the tidal streams carry down silt and other material from the land. Thus certain flats in a harbor will be sand and others mud, the former being swept by strong currents, the latter lying in more quiet waters. Occasionally two other factors enter into the formation of mud flats, viz., eelgrass and mussel beds, the first serving as a lodging place for the deposit of silty material, which in its decay forms a layer of mud upon a previously hard

flat, while the second collects the silt and deposits it beneath the layers of mussels. Under changing natural conditions mud flats are continually being formed and altered, chiefly by the varied action of currents. In such locations the type of shell present is similar both to the gravel and to the sand clam; and although lighter than the former it is heavier, broader and rougher in texture than the latter, but still not as irregular as is the shell of the gravel clam.

The quantity of food on mud flats is relatively greater than on sand flats, in spite of algæ and diatomaceous crust, since diatoms reproduce more quickly on a mud bottom. This fact is indicated by comparing growth during summer and winter on sand and mud flats in Plymouth Harbor, where sand flats gave a greater summer growth and mud flats a greater winter increase. During the summer the better circulating water over the sand flats contains a greater quantity of food forms, while during the winter the measure of food is less and the clams less active. The mud clam, with a larger food supply at hand, is enabled to obtain more nourishment in the cold weather.

In addition to smothering clams, soft mud is unsatisfactory when there is considerable decaying organic material present which injures the shell and secreting edge of the mantle. The fine particles clog the gills, and by thus interfering with the mechanical feeding process eventually starve it or seriously inhibit growth. Slime on the surface of the soil prevents the set of small clams, making a flat virtually unproductive. Yet large clams have been found by the writer in mud so soft that a clammer would sink ankle deep in it. Clams will invariably grow when planted on hard mud flats, the rate of growth depending rather upon circulation of water than upon the character of the soil.

*Gravel.* — Gravel flats are less extensive than either sand or mud flats, but clams are nearly always present in varying abundance, though many apparently superior sand and mud flats are unproductive. The shells of these clams are often rough and distorted and lined with coarse growth lines, since gravel and stones by pressure warp their form. The weight of their shells is greater than is the case with sand and mud clams, since their environment necessitates a strong protecting case. While soil thus exerts an indirect influence upon the shell of the clam, actual nourishment and lime salts are obtained directly from the water. All classes of gravel from fine to stony, usually with a

mixture of mud or sand, are found along the narrow tidal beaches.

*Unproductive Soils.* — Between the tide lines are found two classes of flats, productive and unproductive or barren. Often these differ markedly, but at other times appear to be alike, except that one produces clams while the other does not. Even different parts of a single flat may vary in this respect, as in one harbor a certain type of flat may furnish good clamming while in another harbor the same style, similarly situated to all appearances, is unprolific. Usually the boundary line is sharply marked. Chemically there is little difference except that in some flats more or less organic matter is present, and analysis of the soils throws little light upon the subject.

Unproductive flats may be subdivided into two classes, permanent and temporary. The latter includes those flats which for some reason never catch set, but upon which clams will grow when planted, and those flats which, owing to changing natural conditions, are temporarily unproductive, although this latter type may become permanently unproductive if old conditions do not return. In such cases large beds of clams are suddenly destroyed, the shells remaining upright in the soil in large numbers, as in the case in Pine Creek, Plum Island, and on Greys Flat, Plymouth Harbor. The other type of temporarily unproductive flats is well adapted to clam culture, and it is a material object of this report to indicate how thousands of acres may be reclaimed. The term permanently barren flats includes a large proportion of the tidal flats of the Commonwealth which are of three kinds, — those which can never be reclaimed, those that may be utilized only after considerable expense, and those which may be made productive at a comparatively slight cost. Let us therefore consider some types of unproductive flats and note how they can be utilized.

(1) *Eelgrass.* — Many flats, *e.g.*, those in Plymouth Harbor, are overgrown with thick eelgrass and have accumulated heavy deposits of soft mud, raising the surface above its normal level. By gradual encroachment of eelgrass, flats once productive have become barren, and if it were not for continual digging certain productive flats might be ruined in this way. The presence of eelgrass is brought about by natural changes in current and tide. The reclamation of an eelgrass flat, though difficult, may be brought about by destroying the grass and roots and allowing the current to carry off muddy deposits. In a certain sense some

eelgrass is beneficial, as it prevents the erosion and makes some flats inhabitable for clams. Decaying eelgrass in soil, shutting off of circulation, and the collection of slime and silt seriously interfere with the growth and life of the clam and render eelgrass an undesirable feature.

(2) *Mussels.* — Clams are occasionally found in mussel beds, but in such instances they are either the young which have been caught in the tangled byssal threads of the mussels, or a few large specimens which have been able to survive, despite the accumulation of mud. When so situated growth is somewhat impaired, since both species utilize the same microscopic food forms. The mistaken impression that clams are more abundant in mussel beds arises from the fact that these localities are not dug as constantly as are other flats. As a matter of fact, the actual number of marketable clams in a mussel bed, especially when there is considerable mud, is rather small.

Small clams are found both in the soil under the mussels and attached to their byssal strands. The prevalence of young clams in such a position is easily explained by the fact that the mussel beds act as spat collectors, both catching and protecting the larvæ as they settle from the water, whereas clams setting upon an open, unprotected flat are soon washed away. In such instances, the young clams either burrow amid the mussels or in the near-by mud. However, not only the "set" but also the small clams washed across these beds are caught. In the case of Wind Flat, Plymouth, the presence of clams in mussel beds, and their absence elsewhere, may be explained by these facts.

Mussels eventually ruin a clam flat by gradual encroachment. At first a few small specimens collect on a good flat, and as they grow, others are caught, with resulting enlargement of the bed. If conditions are favorable, fine silt soon collects and the bed extends itself over the surface of the flat, placing over the hard soil a top layer of soft mud formed in part by accumulated débris and in part by deposition of mud from the gills of the mussels. Thus, flats may be rendered practically useless for clam growth but may be reclaimed by removal of the mussels, which necessitates considerable labor unless winter currents and ice come to the aid of the planter.

In the midst of a large mussel bed an experimental clam bed, comprising 196 square feet, was planted for the purpose of determining the actual influence exerted by mussels upon the growth of clams, both with regard to soil and food, and to obtain a com-

parison of results and growth with beds on the sand portions of Wind and Whites flats. The soil utilized was a dark, soft mud, rich in organic material, deposited by mussels on what was originally a sand flat swept by an excellent current.

Wind Flat, centrally located in Plymouth Harbor, lies to the west of Long Beach, and is separated from Whites Flat on the north by Goose Point Channel. It comprises an area of approximately 135 acres, of which 45 on the northwest side are covered with eelgrass and about 30 acres to the southeast are set with mussels. The dark soil among the mussels and in the eelgrass is in many places soft and muddy, while the remainder, which is slightly lower but without clams, is sandy. In 1906, among the scattering mussels, which shift from year to year with the ice, were clams of the 1904, 1905 and 1906 sets, the last in larger numbers.

The bed planted Oct. 27, 1906, was taken up Aug. 16, 1907, having been in for a period of nine and two-thirds months. The clams showed a gain in length of 21.02 millimeters for clams 38.5 millimeters in size when planted, which would make the gain in length in terms of a standard 25-millimeter clam 29 millimeters, or a gain in volume of 1,019 per cent., hardly as rapid as the tide and current would indicate. Undoubtedly, rapid growth is slightly prevented by excessive silt gathered by mussels, the possible but improbable decrease in the food supply, and formation of organic acids in the soil, which interfere with shell formation.

(3) *Organic Material.* — Clams are usually absent in soils which contain an abundance of organic matter. One reason is that the slimy surface prevents set; but in many instances clams when planted in these soils soon perish. Organic acids corrode their shells and interfere with the shell-forming properties of the mantle. Such soils indicate a lack of drainage, and clams do not grow as well in such places as in better drained soils. The lower layers of such are dark, show insufficient aeration, and in certain types give forth a hydrogen sulphide odor. In some there is an abundance of decaying matter, such as disintegrating clams, dead eelgrass, shells, worms and other material which produce a foul odor. The conditions which are unfavorable for the growth of the clam seem favorable for certain worms, creating the impression that worms are the cause of the absence of clams, whereas underlying conditions are the real cause. In certain rivers, particularly the Charles, Mystic and Taunton, clam flats have been ruined in certain localities by accumulations of manu-

facturing wastes, chiefly of the petroleum group, which not only render clams unpalatable but reduce the surface of the flats to a state unfit for receiving clam set, and finally in extreme cases actually destroy adults.

(4) *Shifting Sand.* — Clams are rarely found on exposed shores. Shifting sand, the habitat of the sea clam (*Mactra*), does not permit the growth of the soft clam, which is native to the more sheltered flats and beaches. Kellogg (4) states that it is impossible for clams to live where there is much shifting of the bottom, and that a somewhat tenacious soil is desirable. He states in his report: —

> Clams are sometimes found in beds of almost pure sand, but in such cases the water currents disturb the bottom very little. Even when established in such localities, however, their condition is precarious, for a gale or an unusually strong tide may at any time overwhelm them.

While shifting sands are as a rule an indication of unproductivity, set will lodge wherever a suitable opportunity is offered, as is shown by the following instance. The stretch of exposed sandy shore on the eastern side of Buzzards Bay, between Quisset Harbor and West Falmouth, is occasionally broken by jutting rocky promontories which afford a little protection by breaking the force of the waves. Within this sheltered space clams were obtained in a stony soil, although the rest of the beach was entirely barren.

Flats of fine sand are more compact and can resist fairly strong current of water before the surface becomes deeply rippled, while deeper layers are undisturbed. For this reason adult clams in this compact soil, with a good food supply, are little affected. Nevertheless, such flats are usually barren, because young clams do not gain a permanent foothold. Quantities of set are occasionally found on slightly rippled flats, but eventually they wash away. This type of flat responds readily to artificial culture, provided shifting is not too severe and that large seed is planted, although there is some risk attached to such selection, since storms and high running tides are also to be contended with.

The flats of Monomoy Point afforded opportunities for observation upon the effect of shifting in flats of coarse sand. Clams, particularly large specimens, will stand a considerable amount of shifting, as was observed in the advancement of shifting sand from a new inlet of the ocean over a clam bed on the Powder Hole Flats. Records were made of the depth of this shift and

the clams found at various parts at weekly intervals. The clams withstood it surprisingly well, as they were found living beneath an added layer of at least 4 inches deep in some cases. Although such a shift may not at once destroy a bed of large clams, it stops their growth by interfering with their feeding, as the constant rubbing of sand against the shell causes withdrawal of the sensitive siphon.

*Reclamation of Unproductive Areas.* — The important problem at hand is the development of the waste areas and the barren flats of the seacoast, while at the same time the yield of the areas once productive is increased by allowing the fishermen to reclaim such territories. The means by which this may be accomplished at present, although there are undoubtedly many other available methods, are briefly as follows: —

(1) *Natural Changes.* — Nature is constantly changing. From year to year the coast line varies and slight influences frequently result in great alterations. The shifting of a current may either make or destroy a clam flat, soft mud flats may become hard, eelgrass may be swept away, shifting flats may be made firm, or the reverse may be true.

(2) *Planting.* — Certain barren areas are in such good condition that it is necessary merely to plant them with seed clams to make them productive. This type of flat would produce clams except for certain peculiarities which do not permit the set to catch, and unless artificially aided remain barren. Clam culture is especially advocated for such places, as there are thousands of acres which if properly handled might become of value to the fishermen.

(3) *Hardening.* — Soft mud may be artificially transformed into a good clam flat. At Newburyport an eelgrass flat with a surface layer of soft mud was converted into a productive hard flat by digging. A strong current removed the loosened material, and a new flat about 1 foot lower than the original was formed. The surface of a soft flat may also be made firm by covering with sand or gravel, either through the agency of a storm or manual labor. Instances of flats being formed in this way by dredging deposits in Plymouth Harbor and in the Annisquam River at Gloucester are on record. In these cases the material dredged from the channel was dumped upon unproductive flats and formed a firm surface for catching seed clams.

(4) *Elevation and Drainage.* — A comparison of clam growth in elevated beds with that in natural flats at North Plymouth

gave valuable as well as interesting results. In the course of this work three artificially elevated beds, each with a control on the natural flat, were placed in different locations on the shore flats, most generally located in soft mud, while a fourth was placed on Greys Flat. The prepared beds were located in similar soil, but bounded by boards which raised their surfaces an average of 10 inches above the level of the surrounding flat. The soil of these elevated beds soon became firm, apparently owing to the better drainage secured. The original purpose of this experiment was to determine the effect of drainage upon growth, but it was later ascertained that this was simply a minor factor in a large problem.

The first experiment, beds Nos. 111 and 112, were located in a shore area of mud and sand, where clams naturally grew abundantly, but slowly, about 50 feet from mean high-water mark, just at the beginning of a channel leading eastward through eelgrass-covered flats. Both the elevated bed, No. 111, and the control, No. 112, were covered with water about fourteen hours out of the twenty-four.

The second experiment, beds Nos. 109 and 110, were located to the south of this channel on flats covered with eelgrass and soft mud. The control, No. 109, had a surface of soft mud from 4 to 5 inches deep, upon a layer of hard brown mud in which the clams rested. No natural clams were found in this soil, and it was of such a consistency as to permit one to sink ankle deep. The elevated bed, No. 110, had a surface of hard mud about 10 inches above the level of the flat.

The third experiment, beds Nos. 107 and 108, were situated about 150 feet from shore on a mixed soil of mud, sand and rocks, covered with a slimy ooze. In spite of this slime a considerable number of clams grew here naturally. Bed No. 107, which was raised 12 inches above the flat, was not slimy. The growth was followed regularly from 1907 to 1910, and showed appreciable variation. In terms of 100 per cent. for the box bed, the growth in length for the control bed was for 1907, 51.43 per cent.; 1908, 85.21 per cent.; and 1909, 73.53 per cent., an average of 70.06 per cent.

The fourth experiment, bed No. 134, was tried on Greys Flat in soft mud and eelgrass, where there was no natural set. The growth in the raised box was approximately the same as in experiment No. 111, while none of the clams in the control bed survived.

Raised clam bed in Plymouth Harbor. More rapid growth obtained on the raised beds than on the low flats near by.

Results showed that the growth in the raised beds was about twice as fast as in the controls.

| Beds. | Gain in Length (Per Cent.). | | Gain in Volume (Per Cent.). | |
|---|---|---|---|---|
| | Box Bed. | Control. | Box Bed. | Control. |
| 111 and 112, . . . . . . | 100 | 33.24 | 100 | 30.95 |
| 109 and 110, . . . . . . | 100 | 54.71 | 100 | 41.66 |
| 107 and 108, . . . . . . | 100 | 70.06 | 100 | 56.89 |
| Average, . . . . . | 100 | 52.67 | 100 | 43.17 |

Drainage as an individual problem was tested at Monomoy Point in 1907 with negative results. Four beds were planted in different parts of the Powder Hole Flat, each consisting of two parts, one a water-tight butter firkin, sunk to a point level with the surface of the sand to serve as the undrained portion, and the other the natural clam flat. Three sizes of clams, 75, 55 and 45 millimeters, were planted in each division, and the rate of growth in each bed was obtained for six months.

This experiment showed conclusively that there was practically no difference in growth between the two types of beds, the undrained portion giving an increase of 140.7 per cent. and the drained 136.7 per cent. from May 8 to October 15, for clams averaging 50 millimeters in length when planted. The slow growth recorded was due to the long exposure of the flats, which were scarcely covered three hours out of twenty-four during this period, and at times were exposed continually for a week or more during low running tides.

The mere fact that raised beds are better drained and have harder and more compact soil does not account for the increased growth. Elevation above the flat is probably an important factor, since it allows a better circulation of water, particularly on the eelgrass flats. Also, clams so located are protected from silt, soft mud and slime, and have more freedom in feeding and waste less energy in casting off surplus material which might clog their delicate gills. In experimenting with quahaugs it was found that raised beds, although continually under water, gave a greater growth than did those on the surface, a fact to be explained by the protection afforded the quahaug while feeding.

Whatever explanation might truly be given, growth in an elevated bed is faster than on the natural, soft, undrained flat.

Methods of reclaiming soft flats, especially when covered with grass, might be based on this principle of raising the level of certain parts with gravel and sand.

(5) *Thatch.* — Thatch is present on the higher portions of many clam flats, varying yearly in amount and location. If clams are to be found anywhere they will be discovered in thatch banks, imbedded in the wirelike roots of the plants. Kellogg (3) considers these areas of inestimable value as refuges for breeding clams, owing to the difficulty of commercial digging in such places. In certain harbors, like that at Barnstable, ice tears out great pieces of marsh turf and the tides sweep them down the harbor. Some are torn to pieces and wash away, others find lodgment on the broad surface of tidal flats. Sediment accumulates, grass grows, and gradually a thatch island is formed. Surrounding these islands and often growing over their entire surface, bedded among the roots, are thick sets of clams. Thatch islands become the natural spat collectors for the small clams, which later migrate to surrounding flats. In this way barren flats are reclaimed naturally as the thatch prevents shifting of the surface and affords protection to the clams. The warm water of the thatch pools supplies an abundance of food forms, but on the other hand the decayed material and scum present are by no means beneficial. Clams in thatch usually grow slowly, owing to the difficulty of penetrating the thick mass of roots, lack of current and long exposure because of high elevation. In this connection it is interesting to consider the possibilities of reclaiming certain classes of barren flats by judicious planting of thatch, which gives tenacity to the soil and prevents shifting. Thatch is useful not only in catching seed but in preventing the washing away of small clams after they have set. This plan is now being carried out with apparent success by Mr. Marcus Howes of Barnstable on a smooth clam flat swept by a strong current.

*Character of the Soil.* — The effect soil indirectly exerts upon the clam by interfering with feeding as well as influencing food supply is of interest, since the character of the soil determines the amount of food and sediment that is in suspension in the water during strong winds. In some cases a great quantity of material is collected on the surface and when the water is disturbed it becomes roily and the clam is either forced to stop feeding or expend its energies in getting rid of these substances, thus practically starving. This point was illustrated in a test at Monomoy Point in 1906 by keeping clams in jars of

sand in the laboratory. The water in them was changed regularly, and one lot received the contents of the tow net with a great surplus of food, while the other was supplied simply with salt water. At the end of one month neither lot had grown any, showing that both from a lack of oxygen to stimulate feeding and from a surplus of food forms, which acted similarly to roil, the clams were able to make no growth.

*Growth out of the Soil.* — Clams were placed in wire baskets and suspended from a raft, where they continued to grow more slowly than in their natural environment, thus proving that the clam gets its food and lime salts from the water and not from the soil. However, the unprotected nature of the clam renders this method of growth of little real value, as the mortality is much higher than with the quahaug, with its close, hard shell, and a good portion of the clams thus placed were lost. It is only interesting inasmuch as proving that they will live out of the sand.

## RECOMMENDATIONS.

*Restocking Barren Flats.* — Two groups of flats come under the term barren: (1) flats which once produced clams in great numbers but now are practically barren, except for small areas here and there; (2) flats which never have produced clams and on which, for physical reasons, clams can never grow.

Experimental beds were planted on certain flats in the Essex River which come within the first group of barren flats. These, once productive, had been dug out and for some reason had not seeded naturally. Forty beds were laid out under all kinds of conditions, with the object of finding a means of making these productive once more. Results were all that could be hoped for. Out of a total of forty beds thirty-six were in thriving condition, in spite of the fact that no attempt was made to choose the best locations, the object being to test all conditions. Over two-thirds of the clams were redug, and the increase averaged at least 10 quarts for every quart planted.

If vast areas of Massachusetts flats, at present idle, are capable of such rich yield, should such economic waste be allowed? Why should not the towns, by the expenditure of a little money, restock flats such as these for the benefit of their inhabitants? It is true that all flats may not be productive in this way, as in many instances the mere sowing of seed clams will not restock them; but Massachusetts surely possesses enough flats of the

former nature to yield great profits to her clammers. Where clam set occurs it is usually present in fabulous quantities. The transportation of the seed clam is comparatively easy, and planting requires but little labor when done by sowing, which is the most practical means. It can readily be seen that all things taken into consideration the yield in proportion to the labor is very great.

*Brood Grounds.* — For the ultimate conservation of the clam supply in any given locality or harbor it is strongly recommended that digging be prohibited on certain flats, which should be set aside for "brood grounds." Small sections, not over an acre in size, should be located at various points and zealously guarded, since mature clams so protected will furnish sufficient spawn to seed the other flats. To a limited extent Nature does this by means of the large clams hidden in thatch banks and below low-water mark, where they are free from molestation. It is necessary that man assist Nature in this work of propagation by guarding such brood grounds.

*Size Limit.* — Inadequate territory and constantly increasing demands have led to certain abusive methods. One means particularly in point is the universal custom of digging small clams for food. In certain vicinities, where the supply of suitable clams proves insufficient, people will gladly take "anything with a shell on," so that it is now no uncommon sight to see clams of little over one inch in length for sale. This deplorable condition is fostered by the custom of digging under water, since the fine mesh of the woven-wire basket used retains even the smallest clams, which in most cases are saved for market.

No quicker way of destroying the industry than this method of digging small clams for food could have been devised. One barrel of these clams produces approximately 10 barrels of marketable clams if left for one year under favorable circumstances. Thus, when a clammer digs 1 barrel of immature clams, in reality he is destroying 10 barrels.

Because of the inherent difficulties of the problem, local regulations seem powerless to stop this evil. Clammers, while they know that these methods, if long continued will ultimately have fatal results, nevertheless seem willing to sacrifice the future supply upon the altar of present demand.

Perhaps it might prove difficult to enforce laws preventing the digging of seed clams by individuals for their own use; but there is pressing need of legislation which would prevent the sale of

small clams in the public market, and thus deprive the practice of its worst features.

*Closed Seasons.* — Closed seasons in themselves have proved a failure in respect to the clam industry of Massachusetts, and unless accompanied by cultural methods they accomplish little. The mere fact that towns close their flats totally or in part for a definite period does not to any appreciable extent relieve the situation, inasmuch as when the flats are again opened to the public the increased amount of clams which have accumulated during the closed season are more rapidly marketed by a larger number of clammers. In but one respect is a closed season a logical and economical means of increasing the clam supply, and that is when combined with clam farming. In this way the market will not be overflooded, more men will not be enticed into the business for short-time periods, and the situation of the clammers will be materially improved.

*Grants as Spat Collectors.* — The chief object of the clam culturist should be to so arrange the location of his grant as to make it catch the seed clams. The culturist who is able to select a grant which seeds itself naturally, or to take advantage of its contour so that he may be enabled to increase the natural set by artificial means, will have a great advantage over one forced to pay for the transplantation. If more intensive study were given this problem, and efforts made to develop the industry along these lines, much would be accomplished toward putting clam farming upon a very remunerative basis.

*Improved Methods of Shipment.* — Improvements in the methods of handling and transporting shellfish are much to be desired. Such injurious practices as "floating," which, although more prevalent in the scallop and oyster industries, are applicable to the clam, are to be deplored, mainly because of the unsanitary conditions under which they are carried on.

Since the advent of cold storage advances in the preservation of food mollusks have naturally followed, but the product of our modern plants, though perfectly edible, is noticeably inferior in food value. Results obtained are generally not nearly as good as are obtained with fish. Rapid transportation from the producer to the consumer is essential, as is also careful packing to guarantee arrival in perfect condition. With proper facilities in the form of shipping stations for repacking and icing consignments en route, there is no evident reason why clams should not be shipped even in warm weather to our western States.

## TABLES.

The following tables, which were formulated during the investigation, are presented for the use of the clam culturist in determining the productivity of new ground.

The method of procedure in determining the growth on a prospective grant for a series of years by means of these tables is as follows: —

(1) The culturist must obtain the growth for a definite period of not less than two months during the summer by planting a small experimental bed with clams of a known size. The simplest way is to notch the edges with a file, then the new growth can readily be measured when they are taken up. The reason for having the growing period no less than two summer months is due to the slow growth immediately after transplanting, as described under "Transplanting." The planter then has at hand the following data: (*a*) size planted; (*b*) gain in length for a certain known time, *e.g.*, in one instance 40-millimeter clams grew to 48.92 millimeters, a gain of 8.92 millimeters from July 1 to September 1.

(2) By means of Table 1 (monthly values) we find that the annual growth at Monomoy Point is therefore 27.68 millimeters.

(3) Table 2 reduces the gain of a 40-millimeter to that of a 25-millimeter clam, which is used as a uniform standard in the experiments of this department. By multiplying with the factor 1.428, in this example the result will be 39.53 millimeters.

(4) From Table 3 the gain in volume is obtained by dividing the water displacement or number per quart of a 64.53-millimeter clam by that of a 25-millimeter, which gives 1,763 per cent., or 17.6 quarts for every quart planted.

(5) By Table 4 the growth on the grant can be calculated to four and one-half years.

*Growth Values of Different Months.* — The table is taken from the monthly measurements of clams from the raft boxes and beds at Monomoy Point and beds in the Essex River, and the value of the various months is presented in terms of the gain for a standard clam of 25 millimeters. Each month is given a number representing the gain in per cent., the entire year being considered as 100 per cent.

TABLE 1. — *Relative Values of Growing Months (Per Cent.).*

| | Monomoy Point. | Essex River. |
|---|---|---|
| January, | 1.88 | - |
| February, | 1.88 | - |
| March, | 1.88 | - |
| April, | 7.63 | 2.50 |
| May, | 12.14 | 8.33 |
| June, | 12.76 | 13.33 |
| July, | 15.39 | 18.33 |
| August, | 15.64 | 18.33 |
| September, | 15.29 | 18.33 |
| October, | 9.63 | 15.00 |
| November, | 4.03 | 5.83 |
| December, | 1.88 | - |
| | 100.00 | - |

*Size and Growth.* — In recording the growth of a large number of various sized clams under the same conditions, sufficient data were obtained to formulate a table giving the comparative annual increase in length for clams from 1 to 90 millimeters in size. If, for example, a 25-millimeter clam, which is taken as a standard size in our experiments, gained 25 millimeters, a 50-millimeter clam would gain 12.5 millimeters, and a 75-millimeter clam, 5.8 millimeters in the same time. From these measurements factors were obtained which, by multiplication, would transform the growth of any sized clam into terms of the standard 25-millimeter clam. This table was of great assistance in reducing the experimental data to uniform figures when it was impossible to obtain the standard size for planting.

TABLE 2. — *Growth Factors of Various Sized Clams in Terms of a Standard 25 Millimeters.*

| Size in Millimeters. | Factor. | Size in Millimeters. | Factor. |
|---|---|---|---|
| 20, | .901 | 24, | .980 |
| 21, | .918 | 25, | 1.000 |
| 22, | .935 | 26, | 1.020 |
| 23, | .957 | 27, | 1.042 |

TABLE 2. — *Growth Factors of Various Sized Clams in Terms of a Standard 25 Millimeters* — Concluded.

| Size in Millimeters. | Factor. | Size in Millimeters. | Factor. |
|---|---|---|---|
| 28, | 1.069 | 60, | 2.817 |
| 29, | 1.093 | 61, | 2.899 |
| 30, | 1.118 | 62, | 2.985 |
| 31, | 1.143 | 63, | 3.077 |
| 32, | 1.169 | 64, | 3.178 |
| 33, | 1.197 | 65, | 3.279 |
| 34, | 1.227 | 66, | 3.380 |
| 35, | 1.258 | 67, | 3.480 |
| 36, | 1.290 | 68, | 3.571 |
| 37, | 1.324 | 69, | 3.672 |
| 38, | 1.360 | 70, | 3.774 |
| 39, | 1.399 | 71, | 3.887 |
| 40, | 1.428 | 72, | 4.000 |
| 41, | 1.470 | 73, | 4.128 |
| 42, | 1.515 | 74, | 4.255 |
| 43, | 1.562 | 75, | 4.301 |
| 44, | 1.613 | 76, | 4.413 |
| 45, | 1.667 | 77, | 4.525 |
| 46, | 1.724 | 78, | 4.643 |
| 47, | 1.786 | 79, | 4.762 |
| 48, | 1.852 | 80, | 4.876 |
| 49, | 1.923 | 81, | 5.000 |
| 50, | 2.000 | 82, | 5.098 |
| 51, | 2.083 | 83, | 5.195 |
| 52, | 2.174 | 84, | 5.264 |
| 53, | 2.247 | 85, | 5.333 |
| 54, | 2.325 | 86, | 5.406 |
| 55, | 2.410 | 87, | 5.480 |
| 56, | 2.500 | 88, | 5.557 |
| 57, | 2.581 | 89, | 5.634 |
| 58, | 2.667 | 90, | 5.714 |
| 59, | 2.740 | | |

*Size and Volume.* — The mere statement of the gain in length does not adequately express the actual increase, which should be stated in terms of volume. In preparing the following table

the measurements and volume of a large number of clams from 1 to 90 millimeters were taken. Owing to the variation in the individual clams, several hundred were used to obtain the volume for each size, except in the cases of the clams below 12 millimeters, which were difficult to obtain. From this table the gain in volume for any size and growth can be readily determined.

TABLE 3. — *Table of Clam Volume.*

| Length in Millimeters. | Number per Quart. | Length in Millimeters. | Number per Quart. |
|---|---|---|---|
| 1, | - | 32, | 249 |
| 2, | - | 33, | 224 |
| 3, | - | 34, | 203 |
| 4, | - | 35, | 185 |
| 5, | - | 36, | 169 |
| 6, | - | 37, | 155 |
| 7, | - | 38, | 143 |
| 8, | - | 39, | 132 |
| 9, | - | 40, | 122 |
| 10, | - | 41, | 113 |
| 11, | - | 42, | 105 |
| 12, | 3,680 | 43, | 98 |
| 13, | 3,150 | 44, | 91.50 |
| 14, | 2,680 | 45, | 85.50 |
| 15, | 2,290 | 46, | 80.50 |
| 16, | 1,927 | 47, | 76.50 |
| 17, | 1,645 | 48, | 73.00 |
| 18, | 1,410 | 49, | 69.75 |
| 19, | 1,222 | 50, | 66.50 |
| 20, | 1,046 | 51, | 63.25 |
| 21, | 910 | 52, | 60.15 |
| 22, | 795 | 53, | 57.00 |
| 23, | 700 | 54, | 54.00 |
| 24, | 620 | 55, | 51.25 |
| 25, | 550 | 56, | 48.75 |
| 26, | 490 | 57, | 46.25 |
| 27, | 437 | 58, | 43.75 |
| 28, | 390 | 59, | 41.50 |
| 29, | 348 | 60, | 39.25 |
| 30, | 311 | 61, | 37.25 |
| 31, | 278 | 62, | 35.35 |

TABLE 3. — *Table of Clam Volume* — Concluded.

| Length in Millimeters. | Number per Quart. | Length in Millimeters. | Number per Quart. |
|---|---|---|---|
| 63, | 33.65 | 77, | 17.10 |
| 64, | 32.00 | 78, | 16.40 |
| 65, | 30.45 | 79, | 15.75 |
| 66, | 29.00 | 80, | 15.15 |
| 67, | 27.65 | 81, | 14.60 |
| 68, | 26.35 | 82, | 14.15 |
| 69, | 25.10 | 83, | 13.80 |
| 70, | 23.90 | 84, | 13.50 |
| 71, | 22.75 | 85, | 13.20 |
| 72, | 21.70 | 86, | 12.90 |
| 73, | 20.70 | 87, | 12.60 |
| 74, | 19.70 | 88, | 12.35 |
| 75, | 18.80 | 89, | 12.10 |
| 76, | 17.80 | 90, | 11.85 |

*Standard Growth.* — The growth in millimeters up to four and one-half years is given for various annual rates of growth, from 10 to 75 millimeters, of a standard 25-millimeter clam. Knowing the annual growth for a 25-millimeter clam, the reader can determine the size at any period up to four and one-half years by referring to the other columns.

TABLE 4. — *Clam Growth up to Four and One-half Years in Terms of the Gain for a Standard Clam of 25-Millimeters.*

| Annual Rate in Millimeters for a 25-Millimeter Clam. | Size in Millimeters at Various Ages. | | | | |
|---|---|---|---|---|---|
| | ½ Year. | 1½ Years. | 2½ Years. | 3½ Years. | 4½ Years. |
| 10, | 25 | 35 | 42.96 | 49.55 | 54.64 |
| 11, | 25 | 36 | 44.53 | 51.20 | 56.43 |
| 12, | 25 | 37 | 46.06 | 53.00 | 58.34 |
| 13, | 25 | 38 | 47.56 | 54.69 | 60.13 |
| 14, | 25 | 39 | 49.01 | 56.28 | 61.82 |
| 15, | 25 | 40 | 50.52 | 57.86 | 63.51 |
| 16, | 25 | 41 | 51.88 | 59.27 | 65.06 |
| 17, | 25 | 42 | 53.22 | 60.80 | 66.68 |
| 18, | 25 | 43 | 54.52 | 62.11 | 68.12 |

TABLE 4. — *Clam Growth up to Four and One-half Years in Terms of the Gain for a Standard Clam of 25-Millimeters* — Continued.

| Annual Rate in Millimeters for a 25-Millimeter Clam. | Size in Millimeters at Various Ages. | | | | |
|---|---|---|---|---|---|
| | ½ Year. | 1½ Years. | 2½ Years. | 3½ Years. | 4½ Years. |
| 19, | 25 | 44 | 55.71 | 63.39 | 69.48 |
| 20, | 25 | 45 | 57.00 | 64.75 | 70.90 |
| 21, | 25 | 46 | 58.17 | 66.00 | 72.21 |
| 22, | 25 | 47 | 59.31 | 67.26 | 73.53 |
| 23, | 25 | 48 | 60.41 | 68.48 | 74.66 |
| 24, | 25 | 49 | 61.48 | 69.64 | 75.55 |
| 25, | 25 | 50 | 62.50 | 70.74 | 77.22 |
| 26, | 25 | 51 | 63.05 | 71.49 | 78.08 |
| 27, | 25 | 52 | 64.42 | 72.80 | 79.38 |
| 28, | 25 | 53 | 65.46 | 73.88 | 80.48 |
| 29, | 25 | 54 | 66.47 | 74.93 | 81.68 |
| 30, | 25 | 55 | 67.45 | 75.97 | 82.77 |
| 31, | 25 | 56 | 68.40 | 76.98 | 83.81 |
| 32, | 25 | 57 | 69.39 | 78.01 | 84.90 |
| 33, | 25 | 58 | 70.37 | 79.02 | 85.95 |
| 34, | 25 | 59 | 71.40 | 80.05 | 87.01 |
| 35, | 25 | 60 | 72.42 | 81.05 | 88.04 |
| 36, | 25 | 61 | 73.42 | 82.03 | 89.08 |
| 37, | 25 | 62 | 74.39 | 83.05 | 90.17 |
| 38, | 25 | 63 | 75.34 | 82.10 | 89.54 |
| 39, | 25 | 64 | 76.24 | 85.02 | 92.33 |
| 40, | 25 | 65 | 77.20 | 85.99 | 93.38 |
| 41, | 25 | 66 | 78.10 | 86.91 | 94.40 |
| 42, | 25 | 67 | 79.06 | 87.87 | 95.45 |
| 43, | 25 | 68 | 80.04 | 88.85 | 96.49 |
| 44, | 25 | 69 | 80.98 | 89.78 | 97.50 |
| 45, | 25 | 70 | 81.92 | 90.75 | 98.55 |
| 46, | 25 | 71 | 82.83 | 91.71 | – |
| 47, | 25 | 72 | 83.75 | 92.71 | – |
| 48, | 25 | 73 | 84.62 | 93.67 | – |
| 49, | 25 | 74 | 85.36 | 94.81 | – |
| 50, | 25 | 75 | 86.62 | 95.79 | – |
| 51, | 25 | 76 | 87.55 | 96.79 | – |
| 52, | 25 | 77 | 88.49 | 97.77 | – |
| 53, | 25 | 78 | 89.46 | 98.81 | – |

TABLE 4. — *Clam Growth up to Four and One-half Years in Terms of the Gain for a Standard Clam of 25-Millimeters* — Concluded.

| Annual Rate in Millimeters for a 25-Millimeter Clam. | Size in Millimeters at Various Ages. | | | | |
|---|---|---|---|---|---|
| | ½ Year. | 1½ Years. | 2½ Years. | 3½ Years. | 4½ Years. |
| 54, | 25 | 79 | 90.33 | - | - |
| 55, | 25 | 80 | 91.28 | - | - |
| 56, | 25 | 81 | 92.20 | - | - |
| 57, | 25 | 82 | 93.18 | - | - |
| 58, | 25 | 83 | 94.16 | - | - |
| 59, | 25 | 84 | 95.21 | - | - |
| 60, | 25 | 85 | 96.25 | - | - |
| 61, | 25 | 86 | 97.28 | - | - |
| 62, | 25 | 87 | 98.31 | - | - |
| 63, | 25 | 88 | 99.33 | - | - |
| 64, | 25 | 89 | 100.35 | - | - |
| 65, | 25 | 90 | 101.38 | - | - |
| 66, | 25 | 91 | - | - | - |
| 67, | 25 | 92 | - | - | - |
| 68, | 25 | 93 | - | - | - |
| 69, | 25 | 94 | - | - | - |
| 70, | 25 | 95 | - | - | - |
| 71, | 25 | 96 | - | - | - |
| 72, | 25 | 97 | - | - | - |
| 73, | 25 | 98 | - | - | - |
| 74, | 25 | 99 | - | - | - |
| 75, | 25 | 100 | - | - | - |

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# INDEX TO CLAM REPORT.

## ABBREVIATIONS.

*a.* — anus.
*aa.* — anterior adductor muscle.
*b.* — byssus.
*bg.* — byssal gland.
*es.* — excurrent siphon.
*f.* — foot.
*g.* — gills.
*ht.* — heart.
*i.* — intestine.
*is.* — incurrent siphon.
*l.* — liver.
*m.* — mantle.
*mt.* — mouth.
*nl.* — nucleolus.
*nu.* — nucleus.
*o.* — otocyst.
*pa.* — posterior adductor muscle.
*r.* — retractors of velum.
*st.* — stomach.
*v.* — velum.

## PLATE I.

**Fig. 1.** — Mature egg ready for union with male cell. Size $\frac{1}{387}$ of an inch.

**Fig. 2.** — Early veliger larva, viewed from the side. The animal arrives at this stage from seventeen to forty hours after fertilization, according to external conditions. The duration of this stage is probably from five to six days, during which the animal leads a free swimming life. Size $\frac{1}{250}$ of an inch.

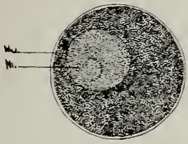
**Fig. 3.** — Late veliger or prodissoconch. Note change in form of shell, the flat hinge line having become rounded. This stage marks the end of the embryonic period.

**Fig. 4.** — Velum somewhat reduced in size. Posterior to the mouth a small foot has developed. Two gill filaments may be observed.

**Fig. 5.** — Velum noticeably smaller. The mouth has extended forward. The foot has increased in size and shows the otocyst distinctly, while three gill filaments have formed.

**Fig. 6.** — Young clam just previous to set. The velum has disappeared in the region of the palps. The foot is relatively large in size, and shows a prominent byssal gland. The gills now have three or more filaments. The heart is definitely discernible.

## PLATE I.



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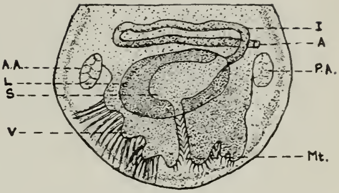


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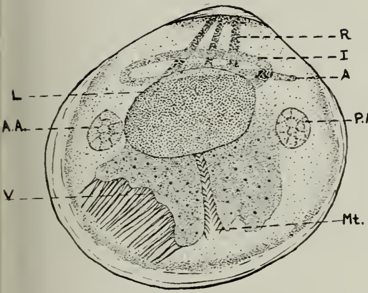


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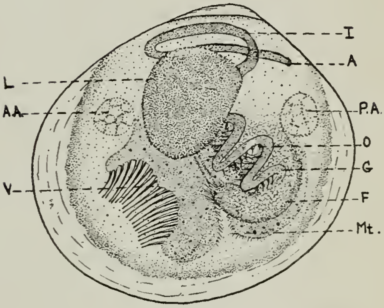


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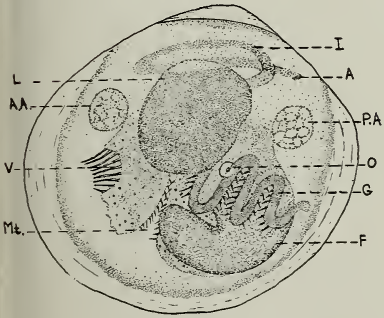


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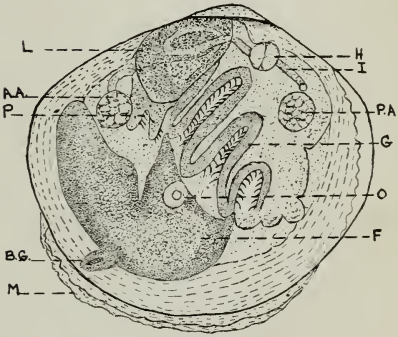


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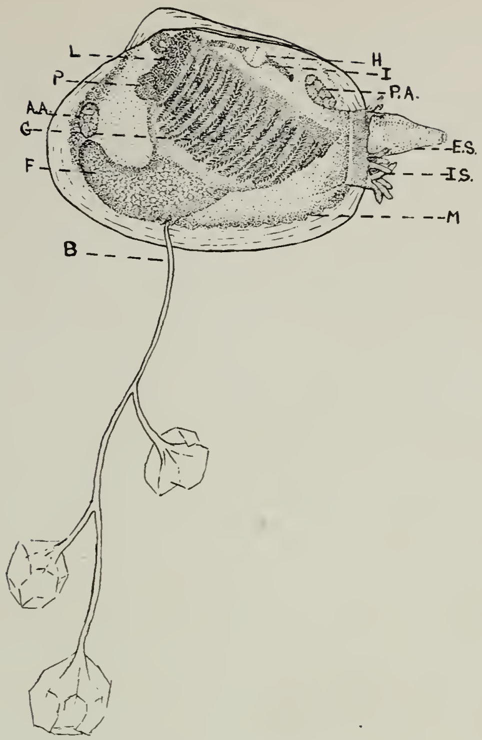
## PLATE II.

**Fig. 7.** — Young clam attached by the byssus to sand grains. Note the formation of the excurrent and incurrent siphons and the increased number of gill filaments.

**Fig. 8.** — A later stage, showing transition to the elongated form of the adult. Note the relatively large foot used in crawling and burrowing. Border of mantle now crenated, and siphon more highly developed.

PLATE II.

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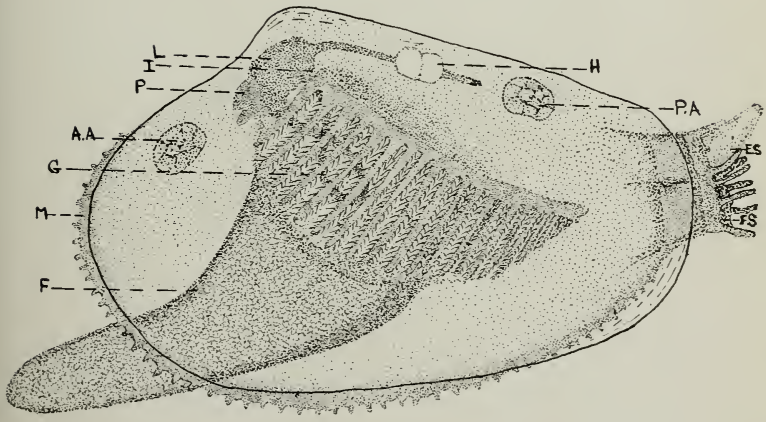


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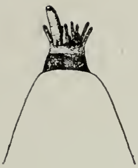
## PLATE III.

**Figs. 9 to 13.** — Development of the siphon. Fig. 9 represents an early stage. There is a filmy, telescopic tube at the excurrent portion, and relatively few tentacles. The succeeding stages indicate the loss in relative size of the telescopic tube, change in form, and increase in number of tentacles. In Fig. 13 the siphon of a clam 1 inch in length is shown.

PLATE III.

9



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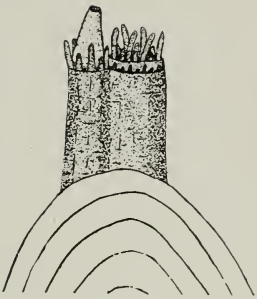

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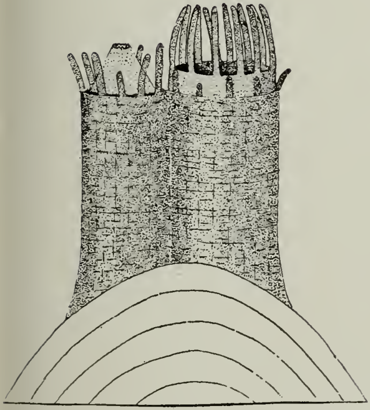

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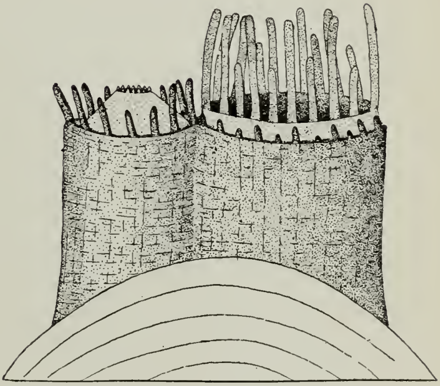

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DEVELOPMENT OF SIPHON

## PLATE IV.

**Fig. 14.** — Change in form of shell. A series of drawings illustrating the changes from the early veliger or first shell (No. 1), which is $\frac{1}{250}$ of an inch in size, to a clam approximately $\frac{1}{12}$ of an inch in length. No. 2 represents the late veliger, just previous to set, No. 3 the form during the first few days after set, and No. 6 the first period of elongation.

PLATE IV.


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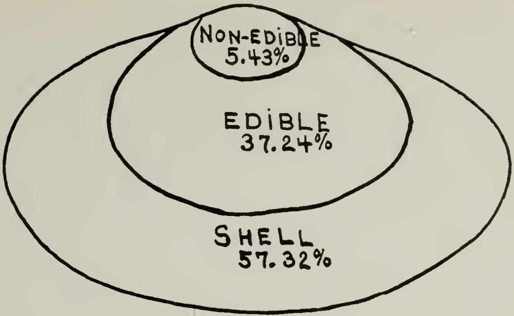
PLATE V.

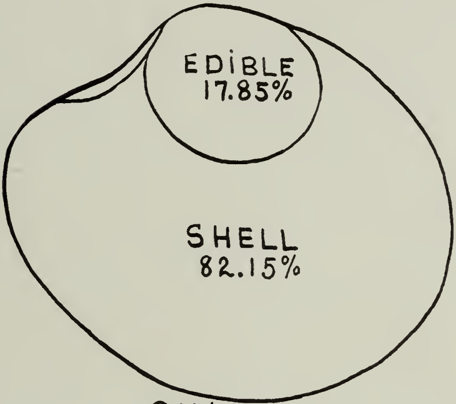
**Fig. 15.** — A comparison of the edible and non-edible parts of the clam, quahaug and scallop.

| | Shell (Per Cent.). | Edible Meat (Per Cent.). | Non-edible Meat (Per Cent.). |
|---|---|---|---|
| Clam, . . . . . . . . | 57.32 | 37.24 | 5.43 |
| Scallop, . . . . . . . . | 49.43 | 17.77 | 32.80 |
| Quahaug, . . . . . . . . | 82.15 | 17.85 | – |

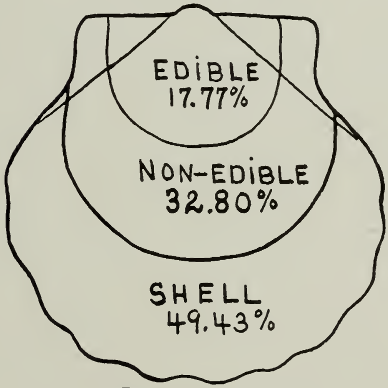
PLATE V.




CLAM




QUAHAUG




SCALLOP

FOOD VALUE

## PLATE VI.

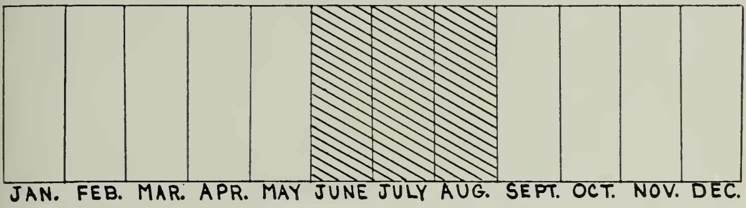
**Fig. 16.** — The spawning season lasts from the first of June to the first of September in Massachusetts, but in any particular locality the duration usually does not exceed two months.

**Figs. 17 and 18.** — The clam does not increase with equal rapidity during the growing months. There is a difference in winter growth in the waters north and south of Cape Cod. The relative value of each month at Monomoy Point and Essex River in terms of the increase in volume for a standard clam is graphically represented.

*Relative Values of the Various Months in Per Cent.*

| | Monomoy Point. | Essex River. |
|---|---|---|
| January, | 1.88 | - |
| February, | 1.88 | - |
| March, | 1.88 | - |
| April, | 7.63 | 2.50 |
| May, | 12.14 | 8.33 |
| June, | 12.76 | 13.33 |
| July, | 15.39 | 18.33 |
| August, | 15.64 | 18.33 |
| September, | 15.29 | 18.33 |
| October, | 9.63 | 15.00 |
| November, | 4.03 | 5.83 |
| December, | 1.88 | - |
| | 100.00 | 100.00 |

PLATE VI.




SPAWNING MONTHS

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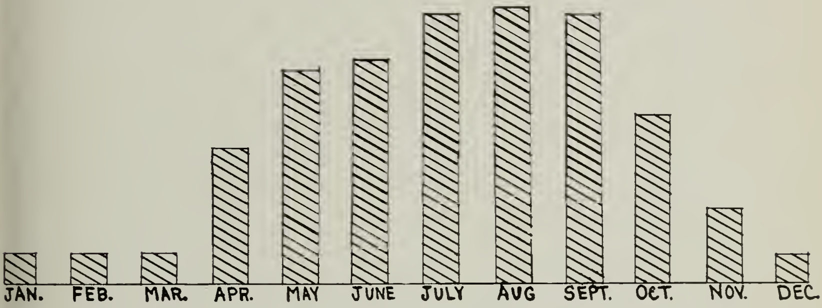
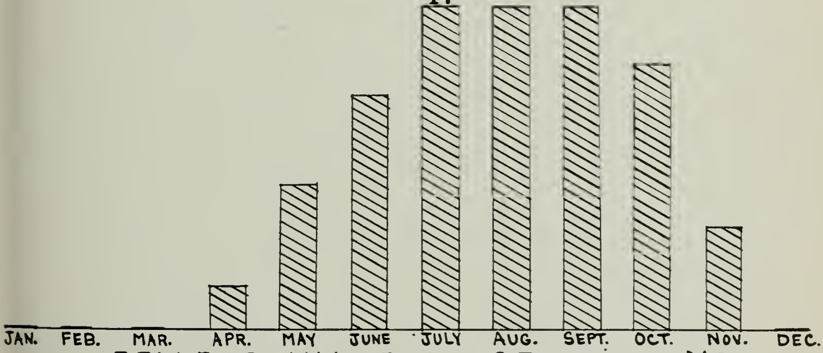



RELATIVE VALUE OF GROWING MONTHS
MONOMOY POINT

17




RELATIVE VALUE OF GROWING MONTHS
ESSEX RIVER

18

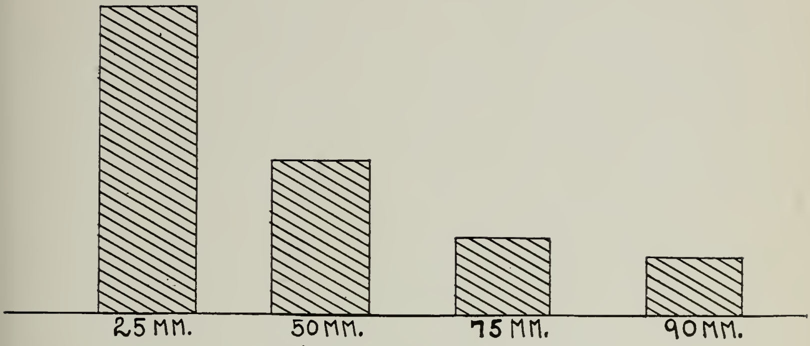
## PLATE VII.

**Fig. 19.** — As a clam becomes larger the rate of growth both in actual increase and gain in volume becomes less. The three columns represent the comparative gain in volume of a 25, 50, 75 and 90 millimeter clam under the same conditions.

**Fig. 20.** — The four columns represent the volumetric growth for a definite period of clams exposed to different conditions of tide. Clams high up with long exposure show slower growth than those situated lower down on the same flat.

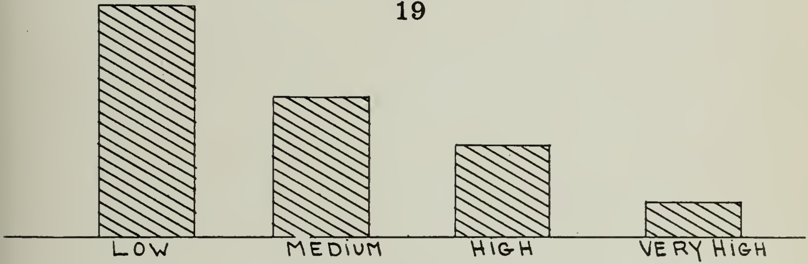
**Fig. 21.** — The four columns represent the growth in volume for clams situated in good, medium and poor currents, and in still water. Clams situated in a good circulation of water have a faster growth than in still water.

PLATE VII.



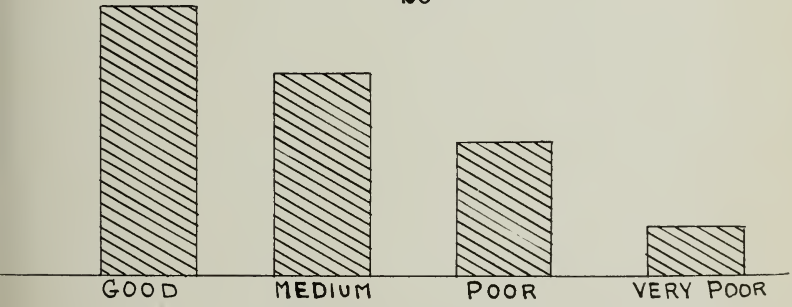

SIZE AND GROWTH

19




TIDE AND GROWTH

20




CURRENT AND GROWTH

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## PLATE VIII.

**Fig. 22.** — Growth of a standard 25-millimeter clam for twelve months under favorable and unfavorable growing conditions.

*Growth (Millimeters).*

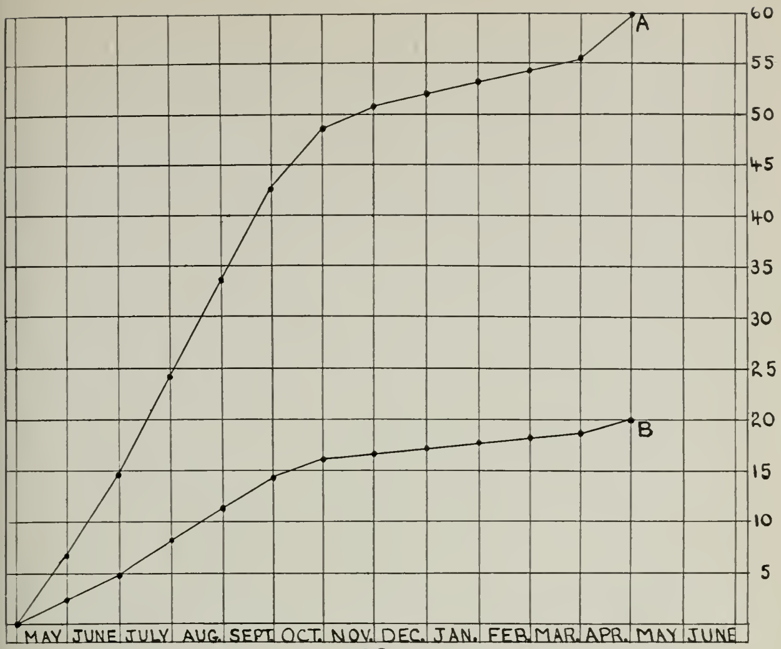
| | A. Favorable Conditions. | B. Unfavorable Conditions. |
|---|---|---|
| June 1, | 7.28 | 2.43 |
| July 1, | 14.95 | 4.93 |
| August 1, | 24.18 | 8.06 |
| September 1, | 33.53 | 11.18 |
| October 1, | 42.72 | 14.24 |
| November 1, | 48.51 | 16.17 |
| December 1, | 50.92 | 16.97 |
| January 1, | 52.06 | 17.35 |
| February 1, | 53.20 | 17.73 |
| March 1, | 54.34 | 18.11 |
| April 1, | 55.47 | 18.49 |
| May 1, | 60.00 | 20.00 |

**Fig. 23.** — Growth for four years. The growth of the average clam under favorable and unfavorable conditions is here given for four years, starting with a clam 25 millimeters in length.

*Growth (Millimeters).*

| | A. Favorable Conditions. | B. Unfavorable Conditions. |
|---|---|---|
| Jan. 1, 1905, | 25.00 | 25.00 |
| Jan. 1, 1906, | 85.00 | 45.00 |
| Jan. 1, 1907, | 96.25 | 57.00 |
| Jan. 1, 1908, | 105.79 | 64.75 |
| Jan. 1, 1909, | 112.50 | 70.90 |

PLATE VIII.

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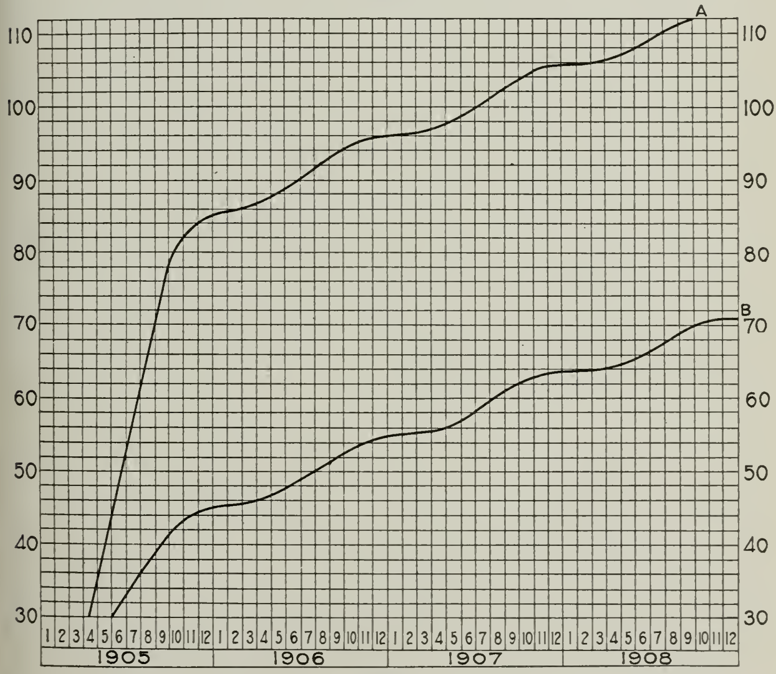


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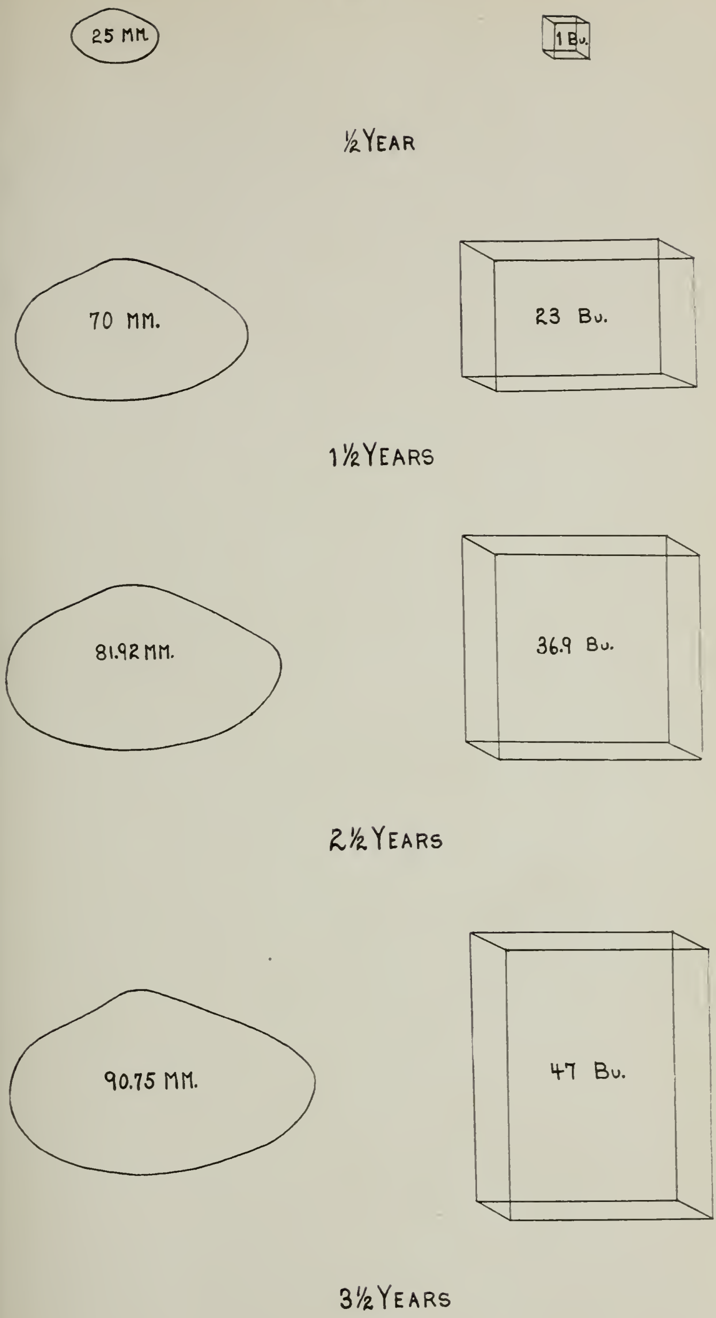
## PLATE IX.

**Fig. 24.** — The growth of a clam from one-half to three and one-half years old is shown with corresponding increase in volume. The figures in the clam outlines (reduced three-sevenths) represent the size; those on the right represent the corresponding increase in bushels.

PLATE IX.


25 MM.
1 Bu.
½ YEAR
70 MM.
23 Bu.
1½ YEARS
81.92 MM.
36.9 Bu.
2½ YEARS
90.75 MM.
47 Bu.
3½ YEARS

Winter feeding station for birds on estate of Mr. F. H. Kennard, at Newton.

Public Document No. 25

# FIFTY-SECOND ANNUAL REPORT

OF THE

Mass:

# COMMISSIONERS

ON inland

# FISHERIES AND GAME

FOR THE

YEAR ENDING NOVEMBER 30, 1917.

BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
32 DERNE STREET.
1918.

State Officers

Publication of this Document
approved by the
Supervisor of Administration.

# COMMISSIONERS ON FISHERIES AND GAME.

WILLIAM C. ADAMS, Newtonville (*Chairman*).
GEORGE H. GRAHAM, Springfield.
ARTHUR L. MILLETT, Gloucester.

**Secretary.**
Miss L. B. RIMBACH.

**Chief Deputy Commissioner.**
ORRIN C. BOURNE.

**Supervisor of Fish and Game Distribution.**
W. RAYMOND COLLINS.

**Biologist.**
DAVID L. BELDING.

Office: Room 321, State House, Boston, Mass.

Telephone: Haymarket 4600.

This report covers the period Jan. 1, 1917, to Nov. 30, 1917.

Hereafter the annual reports of this department will cover the period of the fiscal year, December 1 to November 30 following.

# CONTENTS.

# The Commonwealth of Massachusetts.

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*To His Excellency the Governor and the Honorable Council.*

The Commissioners on Fisheries and Game respectfully submit their fifty-second annual report.

## FOREWORD.

At this most critical period in the history of our country it is most appropriate that the Commissioners on Fisheries and Game once again call attention to the special need of conservation of the supply of fish and game within the Commonwealth, and attempt to bring every citizen to a realization, in some degree at least, of the importance of preserving the wild life in the State. It is particularly desirable at this time that their report should describe the special investigations which have been made along the line of food conservation, and deal at some length with those species of salt and fresh water fish which frequent the coast and inland streams. At our very doors abides a large source of food which heretofore has been incompletely utilized because of ignorance on the part of the public as to the nutritive value of sea foods, and because of inadequate methods of transportation, preserving, handling and marketing, with the resultant increase in prices. It is self-evident that unstinted co-operation on the part of the public is the prime prerequisite.

The development for the public weal of these great natural assets is the goal toward which every effort is being bent by your Commissioners.

The accomplishments of the last year have been particularly noteworthy. An exhaustive study of the alewife fisheries has been completed and definite plans formulated for their re-establishment, which will not only prove valuable directly as a source of revenue to the shore towns, but indirectly will

affect all the fisheries by attracting the larger fish to the Massachusetts coast.

For the first time definite advances toward regulation of the smelt fishery have been made by protecting the spawning beds, catching the spawn and transplanting the eggs, fry and adult fish to various streams and ponds.

The State fish hatcheries have produced many species of fish with which to replenish the lakes and streams, namely, brook trout, rainbow trout, Sebago salmon, Chinook salmon, large-mouthed black bass, small-mouthed black bass, yellow perch, white perch and smelts. All told, 20,096,390 fish and 98,750,000 fish eggs were distributed in the waters of the Commonwealth.

Over 1,000,000 salt-water smelt were hatched and liberated. Three hundred and seventy-eight thousand fingerling Pacific salmon (Chinook), 3 to 5 inches long, were planted in the tributaries of the Merrimack River last October in furtherance of the experiment of establishing the fish in the Atlantic Ocean.

Much attention has been given to the re-establishment of the fishways in the coastal streams, and, under the supervision of this department, a new fishway has been built on the Taunton River. Many others have been repaired and put into shape to permit the passage of anadromous fishes. The matter of rebuilding the fishways on the Merrimack River at Lowell and Lawrence has been taken up and good progress is being made.

Your Commissioners have co-operated with the United States Food Administrator and the fishermen along the coast, and, in order to facilitate a greater catch in the marine fisheries, have urged the towns to grant more permits for the taking of bait fish.

At the State game farms pheasants, mallard ducks, wood ducks and Bob White quail have been reared, and 4,246 birds distributed in all sections of the Commonwealth. There have been 5,863 eggs of game birds sent out for hatching by individuals. All fish, birds and eggs are furnished upon application, and are delivered to applicants free at the nearest railroad station. Also 104 white hares have been purchased and liberated in favorable localities.

During the year past approximately $10\frac{1}{4}$ tons of grain and elevator sweepings have been supplied by the department to deputies and others who are interested in feeding and helping the birds through the severe winter. In addition to this, unrecorded quantities of barn sweepings and other feeding material have been collected and distributed for this purpose. Many clubs and individual sportsmen gave hearty support and valuable assistance in this work.

Four new reservations under chapter 410, Acts of 1911, have been established, adding approximately 7,000 acres of protected area to the reservations already set aside as sanctuaries for bird and animal life.

The amount of money received as a result of the activities of the department, and turned into the general treasury of the Commonwealth, was $53,927.23, as follows: for non-resident hunting licenses, $1,619.85; resident licenses, $47,105.60; alien licenses, $1,089.60; game tags and sales of forfeited goods, $339.76; sales of materials at game farms and hatcheries, $3,723.73; proportion of receipts from fisheries in Buzzards Bay and rent of shanty at Monomoy Point, $48.69. It is safe to say that if a fishing license bill is passed by the next Legislature it will double the amount of revenue received.

The department now has 30 district deputies who give their entire time to the work, besides about 40 town wardens (the number varying as old appointments expire and new ones are made), and a force of about 150 unpaid deputies, likewise varying in numbers. During the past year 355 convictions were secured, in which fines amounting to $9,764 were imposed, of which $4,740 were paid.

Over 37,000 short lobsters were seized in the shipments coming to dealers from outside of Massachusetts. These were liberated along the coast.

Two trout-rearing stations have been built in the western part of the State, one in Montague and the other in Amherst. These stations are well located with an abundant supply of spring water, and should be the means of doubling the output of fingerling brook trout.

Improvements at the State game farm in Wilbraham included a large barn 38 by 48 feet, with hatching rooms in the

basement; a cement incubator house; an ice house; and a four-room bungalow for summer use, making this station one of the most up-to-date game farms in the country.

The brook-trout hatchery at Adams and the game farm at Norfolk have been discontinued and the work consolidated at other stations, with a view to producing more fish and birds at a smaller cost.

Exhibits of live fish and game at sixteen fairs, including the large fairs at Worcester, Springfield and Great Barrington, were a feature of the year's work. This has been a campaign of education, and has acquainted many people with the work of this department.

Of far-reaching importance, also, are the steps taken to increase the output of fish from the State hatcheries, and the efforts made, by salvage, to save many thousands of fish of various species which otherwise would be wasted. The plans of your Commissioners for the future are in the direction of continuing the work along lines already laid down. Results are accomplished only by a persistent continuance on a given policy. Rapid progress in the next few years is anticipated, and your Commissioners expect to be in a position to demonstrate that Massachusetts can develop in a marked degree the great natural fish and game assets within her borders.

## Organization.

In order to make the annual report coincide with the fiscal year it has been deemed advisable to make this report cover the period from Jan. 1, 1917, to Nov. 30, 1917. Hereafter it will be possible to give in each annual report a complete survey of the activities of the fiscal year, whereas heretofore reports have covered parts of two fiscal years.

Under the old order of things it was customary to have the accounts filed by the deputies and the superintendents of game farms and fish hatcheries as of the 10th of each month. Now all accounts are made strictly on the calendar month. The above plan has been found to be of great advantage in avoiding the confusion which attended closing up accounts at the end of the fiscal year, and laying out the financial schedule at the beginning of the following fiscal year.

In the report for 1916 there were outlined in detail certain proposed changes in the administration of the department calculated to put the work on a more substantial business basis, and certain plans for the next fiscal year were stated at some length. Most of these are now in full operation.

In the main, the general plan of work as outlined in the previous report was followed during the past fiscal year.

The new system of bookkeeping put into full operation was found to be entirely satisfactory, and made possible at all times a comparison of the amount of expenditures which were being made with the financial program laid out at the beginning of the year. The system by which deputies and superintendents are required to obtain authorization for expenditures beyond their allowances made it possible to use the small reserve fund which had been set aside in a way calculated to get the most in return and to do those things most needed. The practical result was that, despite the constantly increasing prices of all kinds of materials and fish and bird foods, the uncertainties in the labor market, and the general distraction of unusual times, the fiscal year was completed without overdrawing any branch of the appropriations.

One of the largest benefits derived from the new system of bookkeeping is that it places before each superintendent a detailed account of the expenditures at his station during the year past. Each one has now an opportunity, as the year's work progresses, to study the cost of production, which it is believed will be of practical value in the effort to realize larger outputs at a decreasing cost of production. It provides the superintendent with detailed information as to costs in all branches of his work, thereby giving him data to make comparisons from year to year, to assist in studying economies, and to give him facts on which to base his annual estimate of the cost of operating his station for the next fiscal year.

### *Proposed Changes and Additional Regulations.*

The new system of dividing the deputies into two classes, based on the amount of monthly allowance for traveling expenses, with a requirement that they shall obtain authorization for all proposed additional expenses, has worked so well that there appears

to be no necessity for making any change in the system. However, the work of the deputies is being broadened in scope to take in fields other than that of mere law-enforcement. It has been found that many of the men are developing special abilities in certain fields of work, and they will be given every opportunity, consistent with the limited funds available, to become more proficient. For example, one man has shown unusual ingenuity in the designing of fishways and in handling the problem of the migration of anadromous fish; another has taken hold of the development of the salt-water smelt work along lines which prior to the past year were never attempted; another has shown ability in the laying out and completing of rearing stations; another in outlining and carrying through a comprehensive plan of developing the lobster work. And so it might be possible to enumerate a number of fields of activity in which the men show a desire to specialize, in addition to the straight law-enforcement work. The Board is encouraging its men to be not only officers in the enforcement of the laws, but likewise students of problems involved in developing all the possibilities of the districts in which they are located. Thus it is believed they will play an increasingly valuable part in the general development work being carried on by the department.

At the hatcheries and game farms during the past year the policy outlined in the previous report has been followed, namely, of handling the finances of each station as based on a schedule of estimates. Superintendents were not required to confine their expenditures to the several items estimated on in each month's schedule. The Board considered that it would be very difficult for a superintendent, in the financial schedule made up in detail, month for month, for the entire fiscal year, to figure out with absolute certainty how much of each item in that schedule he would require for the entire fiscal year. They were given a certain amount of leeway, permitting them to shift their plan of purchases as far as individual items in the schedule were concerned, so long as they kept inside the figure which was allowed for each month's operating expenses. This was done on the theory that every superintendent would return to the treasury any unexpended balances at the end

of the month. As a matter of fact, experience showed that while the superintendents acted in good faith, there were, with a few exceptions, no balances returned.

With this fact in mind, and with the intention of scrutinizing even more closely the financial activities of the superintendents, the following plan for the next fiscal year has been laid out: —

Each superintendent's schedule of estimates for running his station during the coming fiscal year will be carefully figured over by the central office, to determine what sums are absolutely necessary for the operation of his plant. These items in the main will represent labor; fish or bird food, as the case may be; feed for such stock as is maintained (horses and cows at the bird farms); certain traveling expenses; telephone, etc. When these are determined, all the rest of the items for which he has made estimates will be stricken out. He will then be notified of the amount which the central office has allotted him, for each month of the fiscal year, for these bare necessities. He will then be required to observe the rules and regulations now in force, — that no additional expenditures shall be incurred unless prior thereto he shall have received written authorization from the central office.

In order to take care of the items which will be stricken out of the estimates, the following plan will be adopted: —

Items which call for such accessories as fish cans, seines, aerators, books, etc., will be covered by a special form of requisition. Before any such items of equipment can be purchased, superintendents will be required to file a requisition with the central office, which must be approved by the central office before the purchases are made.

In reference to those items for building and repair work which include lumber, cement, hardware, etc., superintendents will be required to follow a new plan, thus: —

Early in the fiscal year each superintendent will be furnished with blank forms, three sheets to a set. The first sheet, blue in color, will ask for a description of the item of repair, replacement or new construction work which the superintendent proposes to do. On the second sheet (white) the superintendent will be required to give a sketch or plan showing the pro-

posed work. On the third sheet (yellow) the superintendent will give an estimate of the cost of the proposed work. On this sheet he will also state how much of the labor needed will be supplied by his own men, and how much of the materials to be used are at the time on hand.

All of the work will be divided into separate "jobs," and in the upper right-hand corner of the sheets spaces will be provided for the job number, the date when received at the central office, and when authorized, if ever. At the beginning of the fiscal year the superintendents will file plans for the jobs which in their opinion will be required at their stations during the entire year, retaining copies. When these sheets have been received from all the stations they will be bound, and thus data on all work contemplated for the fiscal year will be in the central office in a compact and clean-cut form.

With these estimates before them the Commissioners will consider each job on its merits, and, out of any reserve fund which may have been set aside over and above the cost of actual necessities for the stations, they will determine which jobs will be authorized. The superintendents will be notified and the estimated amounts of these jobs will be charged up against the reserve fund. As fast as a superintendent incurs bills on a job he will endorse thereon the number of the job for which incurred. The back of the descriptive sheet will bear a form for recording the items of expenditures, which will be entered as fast as bills are received. The bills will then be handled and paid on the same system as has previously obtained, each station being charged in the analyzed account book with the amount of money spent for certain classes of materials.

By the above plan the central office will know exactly what work is to be done at the various stations; the Commissioners will have had an opportunity to determine in advance whether the funds of the department will permit of the expenditures; the work will proceed on the clean-cut basis of description, plan and estimate; and the accounts will be kept in such shape that it can be seen at a glance how closely the superintendent is keeping to his estimated cost of the job.

The property book will show what materials are on hand at the several stations, and all such will be utilized before making additional purchases. The objective is a system which will keep the Commissioners in close touch with all financial transactions without developing needless red tape or duplication of effort.

## EDUCATION.

To-day your Commissioners are only too well aware of the necessity of educating the public to the proper methods of utilizing the fish and game assets of the Commonwealth. Already the passing of some of the most valuable forms of wild life have been witnessed, and it is the duty of this Board to exert every possible effort to preserve for future generations a just portion of the privileges now enjoyed. The Commissioners realize that publicity is the most essential factor in accomplishing this result, and that the public must be impressed with the necessity of this work, since in the final analysis public opinion is the force behind the enactment and proper enforcement of all protective laws. Various means for disseminating information have been tried, and the following methods bid fair to be most successful in furthering this important activity.

### Education of Children.

The most effective way of guaranteeing a permanent supply of fish and game is by instilling into the minds of the boys and girls (who are to be the men and women of the future) the lessons which it is so difficult to teach mature sportsmen. The problem will be completely solved only when natural history, including fish and game protection, is taught among required subjects in the curriculum of the *elementary* schools. At this age the mind is most receptive to instruction, and the lessons learned at this time will exert the most permanent and powerful control in the later life of each one. The true objective is the complete development of all the ways in which our wild-life forms may be enjoyed between the extremes of observing them solely for the pleasure derived from their appearance and action in their free state, and the ardent pursuit, taking and utilization as food. There is plenty of room for all "parties in interest." Each should be encouraged to understand and respect the other's point of view. One of the earliest lessons should be self-restraint and temperateness in the time and amount of taking for sport and utilization as food.

## Boy Scouts.

As a new department of the work, during the past year co-operation has been started with the Boy Scouts of Massachusetts. In this field the Commission has had the approval of the Greater Boston Council. While the work thus far has not advanced beyond the formative stage, it may be stated that the aim is to educate the Scouts to a rather thorough knowledge of the various forms of bird and animal life, together with the necessity and methods of conserving these. Exhibits, illustrated lectures, and such other methods as appear effective, will be employed.

But benefits to be derived by the State would most likely be along the following lines: —

1. Intelligent appreciation of the work the Commission is trying to do, which is always a help toward better efforts.
2. Assistance to the district deputies in times of special emergency. Patrolling certain streams or ponds as requested.
3. Reporting violations of the fish and game laws which come to their notice.
4. Winter feeding of birds, the erection of shelters and the planting of food supplies for the winters to come.

The future only will reveal the extent to which this work may be carried on with mutual benefit. Field days for Boy Scouts, held at State hatcheries or game farms, to which those only are invited who have attained a certain grade on fish and game work, would prove invaluable.

The services of the lecturers of the Commission are available without expense in the vicinity of Boston, or by special arrangement in other parts of the State, the only requirement being that an audience of at least thirty boys shall be guaranteed.

Suitably situated summer camps may be easily established with the co-operation of interested Scout masters, where part of the day can be devoted to courses of study under the guidance of a representative from the Commission. A two-week course would enable scores of boys to take advantage of such a camp and become real amateur fish and game conservationists. There is a constantly growing demand for experienced bird

and fish culturists, and for men in the warden service who have a broad knowledge of the subject. The best men are those who have grown up in the work. Many Scouts may eventually go on into the regular work in this and other States.

## Exhibitions.

The popularity of the educational exhibitions of fish and game at agricultural fairs is shown by the number of requests for exhibits received annually. During the past year these became so numerous that all could not be granted. How much these exhibitions are appreciated is shown by the fact that several associations have erected permanent cages and pens to house them, and the Housatonic Agricultural Society, at an expense of $2,000, has even constructed a special building.

These exhibits consist of live specimens of the fish raised at the fish hatcheries, and of the common food fishes native to the Commonwealth; also of live specimens of the game birds reared at the bird farms. For several years numbers of fancy pheasants, wild turkeys, rare specimens of ducks and geese and hybrid trout have been exhibited. These have been all eliminated in order to center the public interest on only those birds and fish which are being reared for restocking purposes. The general scheme of the exhibits has been as follows: —

1. As the central part of the exhibit, an information bureau where any person wishing detailed information can be received and attended to apart from the crowd; where a register can be kept for recording the names of such visitors; and where literature can be given out.

2. Maps showing the fish hatcheries, game reservations, forests, streams and lakes (especially those covering the locality where the fair is held), so that visitors may point out the particular stream or cover in which they are interested and receive intelligent advice in regard to it.

3. A variety of exhibits illustrating different phases of fish and game work, including the development of the egg and the growth of the fish, the nesting and hatching of game birds, the development of the young, and methods of combating their


Building constructed by the Housatonic Agricultural Society for the exhibit of the Fish and Game Commission at the Great Barrington Fair.

enemies. Where practical, the above features are shown in natural groups.

4. Models and plans showing methods and apparatus used at the hatcheries and game farms.

5. Photographs supplementing the above features, and also showing methods of improving and conducting sanctuaries and reservations.

6. Placards showing the extent and benefits of the Commission's work, inviting co-operation on the part of interested persons, and furnishing information in attractive form calculated to invite further inquiry.

7. Charts developing any of the above features which might thus be shown to better advantage.

8. Identification cards attached to the various displays, giving, in addition to the name, a statement of general information in concise and attractive form.

9. A collection of nests of various birds carefully arranged in rustic cases, showing how the birds make them, and the measures adopted to protect the eggs and young.

10. Specimens in formalin, illustrating the development of the brook trout and chinook salmon; specimens of young shad; food upon which young fish and birds are fed; method of developing the meat fly for game-bird food; pictures of fish, including the process of stripping. The skin of a 52-inch water adder, which contained 120 2-inch trout when killed in a trout-rearing pool, is mentioned as one feature shown to illustrate the large number of enemies of both fish and game.

It may be said of this special exhibit that it reaches many people to whom the live fish and birds do not appeal, and is certainly of sufficient importance and general interest to merit further development. The purpose is not to provide a "free show," but, by a popular presentation, to lay before the people practical ways of taking a hand in the work; to encourage them to utilize the small ponds and streams in the more intensive growing of food supplies or to raise a few game birds for sale; and to appreciate the problems involved in maintaining and increasing the natural supply. Suggestions like the following, displayed at these exhibitions, set many people to thinking to good purpose.

## Sportagrams.

Train yourself to observe conditions when passing through the woods. There is always something new to learn. Be sure this Commission will always be pleased to have a report of your observations.

Feed the birds during the severe winter weather. Directions and a supply of grain will be gladly given upon request.

Aid in every possible way to prevent forest fires. The woods are invaluable as watersheds, and their preservation a necessity for increasing wild life.

Be a *real* sportsman if you hunt or fish. There is more honor in giving a square deal than in getting the limit.

Report all violations of fish and game laws to the regular district deputy commissioner, or to the Fish and Game Commission at the State House, Boston, Mass. All reports are considered strictly confidential.

Teachers, cultivate among school children and others a better knowledge of the habits of birds and animals.

Help to popularize the sport by showing a proper respect for the rights of property owners.

Help to restock the streams which you fish, and show the riparian owners that you are doing something besides "skinning" the brooks.

Don't take small fish when angling. Give them a chance to grow up. YOU had one.

Don't try for the largest number. Try for the largest fish.

## Associations.

It is a great pleasure to recognize the support which the department has received during the year from the sportsmen's associations in the State. Many of these associations have given the Commission valuable suggestions. Some have volunteered to do constructive work in their districts which could have been done by the department only at a large expense; some have outdone their previous performances in the feeding of birds in the winter; others have built bird shelters; others, through their fish and game distribution committees, have more fully organized their machinery to care for the stock turned over by the Commonwealth, so that the plants might be made under the most favorable conditions; some have carried on an increasing campaign of education to bring the sportsmen and

the landowners into a closer understanding, resulting in a greater consideration for the rights of the owners of the property over whose lands they fish and hunt. Since, as has been stated over and over again, the fish and game laws and protective measures are no stronger than the public sentiment back of them, the efforts of the associations in developing this public sentiment have been of inestimable value to the cause.

## National Activities.

The attention of your Commissioners has not been confined entirely to State affairs. They have taken an active part in the various national conferences on the problems concerning fish and game which have become of great moment. By co-operating with other national and State officials, by visits of inspection, and by active official work in numerous organizations, they have acquired new and broader ideas for the development, not only of the resources of Massachusetts, but also of the vast fish and game assets of the United States. The Commissioners are members of and hold important official positions in some of the following organizations: —

1. American Fisheries Society, with membership in the committee on relations with national and state governments. All three Commissioners attended the meeting Aug. 29 to 31, 1917, at St. Paul, Minn. At this meeting a member of the Board was elected treasurer of the society.

2. National Association of Game and Fish Commissioners. The 1917 meeting, held at St. Paul, Minn., August 27 to 29, was attended by all the Commissioners.

3. National Association of Shellfish Commissioners. The July meeting, at Providence, R. I., was attended by the Commissioners and the biologist.

4. Northeastern Association of Fish and Game Commissioners, of which one member of the Board is president.

5. A member of the Board has been appointed on the Advisory Committee to the Department of Agriculture on the Migratory Bird Law.

6. His Excellency the Governor honored this Commission by selecting one of its members to represent the Commonwealth

at the Food Fisheries Conference with the National Food Administration at Washington, D. C., Sept. 24 to 26, 1917.

A complete report of the meeting between the Food Fisheries Conference and the Food Administration will be found in another part of this report.

*The Northeastern Association of Fish and Game Commissioners.*

Among the noteworthy events of the past year was the first meeting and conference of the Northeastern Association of Fish and Game Commissioners, held at the Copley Plaza Hotel on February 17. It was attended by members of the fish and game commissions of the New England States and New York. At the first conference various problems requiring the co-operation of these States were discussed. Considerable attention was devoted to the regulation of the lobster fishery, and by mutual consent a size limit of $4\frac{1}{2}$ inches, carapace measurement (equivalent to 10-inch total length), was decided upon as the most acceptable legal limit for all the coastal States. The Commissioners agreed to use their influence in their respective States to secure the passage of such a measure during the coming year.

In addition to a consideration of the systematizing of clerical work and law enforcement, the subject of the anadromous food fishes received a thorough discussion, which resulted in the passage of the following resolution: —

*Whereas,* The numbers of the salmon, the shad, the striped bass and other valuable anadromous food fishes have become so depleted that extermination is seriously threatened; and

*Whereas,* The depletion of these fishes is largely due to the fact that they are intercepted during their annual migration to their spawning grounds by the use of pound nets and other fishing devices set in waters over which the individual States have no control, and as a result of which attempts to replenish the waters by resorting to their artificial propagation are nullified; be it

*Resolved,* That the commissioners of all of the New England States and of the State of New York here in convention assembled, strongly approve of the Federal control of all anadromous fishes, and commend to the attention of the representatives in Congress the careful consideration of this question; that they urge that earnest efforts be put forth by these representatives to the end that Congress enact a law taking over the

control of all such anadromous fishes on the Atlantic coast; and that a copy of this resolution be sent to every member of Congress from the States here represented, and to the United States Commissioner of Fisheries.

A second conference was held in Providence, R. I., on July 26 and 27, 1917, at which additional work was laid out.

## BIRDS AND GAME.

The general public is coming to realize more and more the existing danger to wild life and the rapidly increasing importance of maintaining the natural supply of birds, game and fur-bearing animals. To-day the words "conservation," "propagation" and "protection," which have been glibly used by many in the past, have taken on a new meaning. These words must be translated into more positive action. They stand for self-denial, closer study of supply and demand, and the restraint of those impulses which would shortly deplete our waters and covers in order to relieve a present though not acute need.

Back of protective laws must be a healthy public sentiment, prompting every person to take the minimum rather than the maximum, and only under conditions which will permit of using all for food. If the supply is to keep pace with the demand, every bird or fish taken from the covers and streams must be replaced with one or more of the same species. The existing wild stock must be given greater freedom from natural enemies in order to do its full share of reproduction. It is strikingly evident that in order to perpetuate the supply, and at the same time afford recreation and food, artificial propagation, both public and private, must be more extensively undertaken. The State hatcheries and game farms are annually increasing the quantity and quality of output; nevertheless, more extensive stocking will be required to meet the demands of the future.

### Preservation.

There are three general means of preserving wild life: —

1. By enforcing observance of the laws. In the main the existing laws cover the subject well. Many of them embody the most advanced position taken by any State. Others show that this Commonwealth has been the pioneer in thought and action on the more important policies. The enforcement of these laws requires more than the activities of the present deputy force. Each man covers a district of approximately 415 square miles, with a monthly allowance for traveling expenses ranging from

$25 to $31, depending on the character of the country he must traverse. It is manifestly impossible for one man to thoroughly cover such a large territory. The enforcement of the game laws depends essentially upon the attitude of the community. Without public sympathy and understanding no law can be adequately enforced. When the public at large, and especially those persons who hunt and fish, wake up to the fact that the laws are not intended as shackles, but rather as guides to the proper way in and extent to which wild life may be taken, and do as a rule reflect a serious effort, on the part of those having most accurate knowledge, to lay out the safe course to follow, then, and only then, will the game laws of Massachusetts achieve their purpose.

2. Preserving birds and animals by providing large areas where favorable breeding conditions exist and protecting them from shooting and their natural enemies. On these reservations they must have shelter and sufficient food during the severe winter weather.

3. Artificial propagation and distribution, either by private individuals or by the State. The private game farm is useful in two ways, — it furnishes birds and game for food, thus satisfying a public demand, and the birds which escape tend to increase the wild supply.

It was but a few years ago that large sections of Massachusetts were practically sanctuaries for game. Many such localities on Cape Cod and in Berkshire, Franklin and Hampshire counties were inaccessible to the average hunter, and the game was unmolested; but to-day good highways traverse all these regions, and the automobile takes the hunters swiftly from one cover to another. New trolley lines, too, have been built, such as the road from Huntington to Lee, through the heart of the game section of Berkshire County.

There is an army of over 60,000 licensed hunters, in addition to the large number of men who are privileged to hunt unlicensed on their own land, all patroling the covers for some kind of game.

The question that confronts us now is, how long will the game last? Are we looking out for the future generations, or simply for ourselves? Many plans have been considered to

require each hunter to make an annual return of the game killed by him, but none has been devised sufficiently simple and effective to be workable with the present force and finances.

### Reservations.

There are two main types, — the private and the State reservation. The typical private reservation comprises estates which are stocked by the owner and upon which hunting is forbidden. Unfortunately, in most instances these estates are too small to be of any great benefit.

Under chapter 362, Acts of 1909, all parks, commons and land held in trust for public use are given the status of State reservations on which hunting is prohibited. The State institution grounds, hospitals and other public lands coming under this act comprise approximately 28,321 acres on which bird and animal life is protected.

Likewise, under chapter 178, Acts of 1902, and other special acts, an additional area of 16,357 acres has been utilized as reservations and State game farms.

Under chapter 410, Acts of 1911, the establishment of reservations by the State is provided for. Upon the petition of all the landowners the property embraced in several adjoining estates may be closed for a period of from three to five years. To insure the success of the reservation the area should be comparatively large (from 1,500 to 2,000 or more acres), with well-defined outer boundaries, such as highways, water courses or railroads. The initiative in this work comes from public-spirited citizens, not from the Commission. Once closed, no hunting whatever is permitted during the prescribed period, either by the public or by the property owners, with the exception that the Commission may authorize persons to hunt and trap vermin.

Results in this type of reservation have proved less successful than was originally expected. It is difficult to secure the consent of all the landowners within a given tract to the terms of closure, and the Commissioners cannot accept any tract which includes the land of a person who refuses to join in the petition. The Commissioners have rather limited control over the land, and there is not that permanency of tenure which makes

possible the laying out of those schemes for development which are necessary to secure the most effective results. Nevertheless, they are better than nothing, and are serving a useful purpose in bridging over the time when the State will establish permanent reservations.

Under this act 18,475 acres have been set apart. During the year past the following reservations have been newly established: —

| | Acres. |
|---|---|
| Lynnfield Reservation, Lynnfield and Peabody, | 750 |
| Taunton Reservation, Taunton, | 2,749 |
| Mansfield-Foxborough Reservation, Mansfield and Foxborough, | 1,800 |
| Bare Hill Reservation, Harvard, | 1,740 |

The Commissioners are of the opinion that the true solution is to be found in permanent reservations owned by the State, of sufficient size to warrant the employment of a superintendent who will protect against poachers, kill predatory vermin, plant grain, and construct shelters where the birds may be fed during the severe winter weather; in other words, make ideal natural conditions for the wild stock. In addition to the State game farms and hatcheries a reasonable number of these State-owned reservations should be established in most counties.

Along the same line the possibility of establishing State-owned reservations for hunting is to be considered.

## Heath Hen.

About the close of 1916 the Board voted to make the experiment of planting colonies of heath hen upon the mainland. This was in line with the policy agreed upon at a conference, held April 21, 1916, at the office of the Commission, which was attended by T. Gilbert Pearson, secretary of the National Association of Audubon Societies, E. H. Forbush, State Ornithologist, Winthrop W. Packard, secretary of the Massachusetts Audubon Society, Dr. George W. Field, Dr. F. W. Rowley, William Day, superintendent of the reservation, and others. This conference was called for the purpose of considering measures for the further protection of this bird. Those present at the meeting agreed that substantially the following steps should be taken: —

1. To consider transplanting colonies to the mainland.

2. To cultivate corn, sunflowers and clover to insure green food during the summer and seeds and grain through the winter.

3. To take measures to protect the birds against danger from fire.

4. To protect against vermin, and patrol against violations.

The New York Conservation Commission expressed a desire to have a substantial number of birds with which to restock Long Island, N. Y. (a once famous range of these birds). The superintendent of the reservation during the month of December, 1916, trapped and shipped to the New York commission 18 birds.

Dr. John C. Phillips, Wenham, Mass., received 8 birds for experiment in breeding the birds in captivity, in closer quarters than were planned by the New York Conservation Commission.

In spite of the fact that those who received the birds were well qualified to conduct such experiments and made elaborate preparations to insure the success of the trials, the results were uniformly unsatisfactory, since in every case the birds failed to mate.

An account of these experiments may be of interest.

Hon. Marshall McLean of the Conservation Commission of New York reported on Dec. 21, 1917: —

> It is with the utmost regret that I have to write you that our heath hen experiment has been a total failure. The last of the birds died about three weeks ago. Investigations of the carcasses failed to disclose any particular disease so far as the records before me show. I cannot tell you how great a disappointment this has been to all the members of the commission.

A more detailed report from Mr. Harry T. Rogers, superintendent of the game farms for the Conservation Commission, states that 18 heath hens (11 cocks and 7 hens) were received. A 3-acre enclosure was ready for them, with natural conditions much like those on the reservation from which they came. The birds were wing-clipped and each placed in a small breeding pen within this enclosure for about two weeks. When they had become acquainted with their new surroundings they were allowed to escape into the large enclosure.

Though pole traps were set for hawks and owls, 7 heath hens were lost through these birds.

About March 1 the heath hen cocks showed signs of mating, going through the usual maneuvers. They did not pair off with the females, but all kept together. The cock birds did not seem inclined to fight, the hens showed no signs of nesting, nor did they lay any eggs so far as could be ascertained.

The birds were fed a balanced ration of wheat, kaffir corn, buckwheat, barley, cracked corn and sunflower seeds, and grains were planted and left standing in the enclosure. Wild berries and insects were also available, though the birds did not eat the latter to any extent.

About July 1 it was noticed that some of the birds looked droopy. Shortly after this they began to die, one about every ten days, until the remaining 11 were dead. Examination showed them to be very thin, almost nothing but bones and feathers. All died with a disease that game breeders term "going light." Any one who has raised game birds to any extent is familiar with this disease, which is tuberculosis of the bowels. In the opinion of the game keeper who had charge of the Long Island colony there was no reason for their failure to breed, as they were surrounded with what was considered very favorable conditions.

Dr. Phillips reports: —

To start with I had three heath hens and five males. I lost one of the females in a most peculiar way. The bird got her head through the wire and her entire head was bitten off by a dog. . . . I mated the pairs in large separate breeding pens in a retired spot, the pens being about 20 by 20 feet and covered. The surplus males were of course excluded. The males of the mated pairs did not "boom" at all during the mating season. Prairie chickens I had before boomed continuously for several weeks, so that I immediately suspected something was not right. One of the spare males was killed in a fight, and upon dissection I found that the sex organs were extremely small, although this was the height of the breeding season. I afterwards examined two others (males, I think) and found exactly the same condition. I shipped the remaining pairs down to Mr. Joshua Crane of No Man's Land some time about early July. . . .

No report has been received as to how the birds have fared on No Man's Land.

Superintendent Day stated that he believed a surplus of cocks was necessary, and that the hens should be permitted to choose their own mates.

During the year consultations, both in person and by letter, have been held with persons interested in the birds, not alone in Massachusetts but all over the country, keeping them informed of conditions and getting their views and advice. Keen interest in this colony is displayed by persons as far off as California. There has been especially close co-operation in this work between the department and State Ornithologist Forbush, the State Forester's department, the National Association of Audubon Societies and the Massachusetts Audubon Society. All those consulted at various times have concurred in the opinion that the proper protective measures to be followed are those laid down at the conference, and the Commissioners have used every effort to carry out this program as far as possible with the means available.

The work accomplished may be summed up thus: —

1. *Distributions.* — Account has already been given.

2. *Feed.* — Three acres of corn were planted and left standing for feed, and $1\frac{1}{2}$ acres of sunflowers, — more, in the superintendent's opinion, than the birds could use. Alfalfa was also left uncut.

3. *Fire.* — The State Forester's department was consulted as to the best means of protecting against fire. During the year that department, with the co-operation of towns on the island, erected a fire tower on the reservation where, during the danger season, some one is constantly on watch to detect fires.

4. *Vermin.* — A vigorous warfare has been kept up against vermin, and the superintendent reports: —

> Twelve cats were shot; 145 rats trapped; 45 marsh hawks, 4 goshawks, 10 red-tails and 8 rough-legs shot. All these hawks had bird life in their stomachs, with the exception that 2 marsh hawks had mice and a red-tail had 2 small snakes.

In addition, following the recommendation of the State Ornithologist, a man has been placed on the reservation whose instructions are to devote his entire time to the heath hen,

with particular emphasis on the destruction of vermin and patrol work. This man has no other duties in the way of law enforcement to distract his attention from the task in hand.

The State Ornithologist has kept closely in touch with conditions, and in the course of the year reported his findings thus: —

On April 18, 1917, in a two-day examination covering about 25 miles on foot and in automobile, he was able to locate only 70 birds. Not satisfied, on April 24 he covered 40 miles. During the two trips he was able to account for 126 birds, among which he observed males to be in excess of females. He estimates 50 pairs on the island, against 800 a year ago. Causes: the great fire which destroyed food and exposed them to enemies, killed females on the nest, resulting in excess males, and destroyed vegetation and insects, depriving birds of food and shelter from enemies.

On Sept. 28, 1917, he reported that the heath hens were fewer in number than at any time within the last nine years. He was able to find but two birds. In his opinion the birds are about down to the point where they were when the Commission first took hold of the work. He suggested that the deputy on the island needs to give his entire attention to the heath hen, excluding all other law enforcement work. He expressed the opinion that if the birds are properly cared for they may still increase.

It is probable that the number of heath hens on the island is greater than the above figures would indicate, for in the course of the year employees on the reservation have seen flocks numbering from 37 to 50 birds.

On Sept. 30, 1917, Mr. William Day, who has covered the double position of superintendent of the reservation and district deputy, resigned to undertake other work. Pending the appointment of his successor, Deputy Elisha T. Ellis was assigned to the reservation, devoting his entire time to the heath hen work. Mr. James A. Peck was selected to succeed Mr. Day, his term of service to commence Dec. 1, 1917.

## Pheasants.

During the pheasant season for 1917 every county in the State was open except Dukes, Nantucket and Barnstable.

The restrictions that were placed on the hunters were a bag limit of two in any one day and six in the season, with a proviso that all birds killed must be reported to the Commissioners.

Summary of the reports received is here given.

*Pheasants shot in Open Season of 1917, November 1 to 30.*

| County. | Cocks. | Hens. | Total. |
|---|---|---|---|
| Berkshire, | 42 | 18 | 60 |
| Bristol, | 147 | 98 | 245 |
| Essex, | 302 | 197 | 499 |
| Franklin, | 23 | 15 | 38 |
| Hampden, | 118 | 48 | 166 |
| Hampshire, | 117 | 78 | 195 |
| Middlesex, | 522 | 281 | 803 |
| Norfolk, | 179 | 101 | 280 |
| Plymouth, | 116 | 66 | 182 |
| Suffolk, | 3 | 3 | 6 |
| Worcester, | 184 | 114 | 298 |
| Total, | 1,753 | 1,019 | 2,772 |

From reports received since the season closed it is evident that a good many hunters failed to make the required return. It is but a small matter to comply with this part of the law, and gunners are informed that the department will try to enforce this provision during the next open season. Sportsmen who have had an opportunity during the past four years to shoot pheasants are loud in their praise of them as game birds of the highest type. From all sections of the State come requests for the liberation of more pheasants. Unquestionably the pheasant has come to stay, and the State will continue to liberate increasing numbers each year from the game farms.

During the past year large numbers of pheasants' eggs have been distributed to farmers and others who have facilities for hatching and rearing the young birds. Printed instructions are sent with each shipment of eggs, and all possible information is furnished. In some cases the recipients were quite successful in raising the pheasants, while others were less fortunate.

It is the policy of the Commissioners to encourage private individuals to go into the work of raising pheasants. At the

present time this work has become an established business, and there is a ready market for all the pheasants that can be raised, either for brood stock or for the market.

Licenses and tags for dealers who wish to rear these birds and sell them for food are issued by the Commission.

There is a demand for young men as game breeders, and unquestionably it will steadily increase in all sections of the country.

### Ruffed Grouse.

When the season closed in November, 1916, it was the opinion of hunters and deputies alike in every section that the ruffed grouse were rapidly increasing, and that a substantial number had been left in the covers to breed. At a convention held in Springfield in January of the present year, which was attended by a large number of prominent sportsmen from Worcester, Springfield, Boston and other sections, it was voted to ask the Legislature to change the date of the hunting season for these birds, making it from November 1 to December 1. It was the opinion of these men that grouse were coming back fast, and that old-time conditions would soon prevail. This expectation, however, was not realized. Few broods of young birds were noticed during the summer, and when the open season came birds were scarce and nearly every one killed was an old bird.

The Commissioners have been to considerable pains to get at the facts from all sections of this as well as from neighboring States, and have reports from reliable sportsmen, wardens, guides and others who know what the exact conditions are. From information gained from these persons and our own observation your Commissioners attribute much of the scarcity of ruffed grouse to the poor breeding season in the spring, coupled with the fact that during the past two years there has been a great flight of goshawks in all parts of the State. It is fully realized that many other factors enter into the destruction of the grouse, such as cats, foxes, owls, skunks, weasels and the illegal hunter, but these are always present, and for that reason the unusual conditions are attributed to the causes named.

It has been learned that this condition is not local, but that it prevails in all the New England States, New York and the

States farther west. What the future will be no one knows. What is the best policy to pursue to save the ruffed grouse from extermination is the question that is occupying the minds of many sportsmen to-day. It must be remembered, however, that it is a well-known fact that similar reductions in the number of grouse have in the past occurred about once in every seven to ten years.

### Woodcock.

Reports show that woodcock bred fairly well in Massachusetts. There is much cover in this State admirably adapted as breeding grounds for the woodcock, though this area and the feeding grounds are becoming more and more restricted owing to drainage of wet lands. Fall reports indicated about the usual number of birds in the covers, both native-bred and flight birds. The change of the season to the month of November (which opened the season in Berkshire, Franklin, Hampden and Hampshire counties October 20) undoubtedly deprived sportsmen in eastern Massachusetts of a part of their sport; but they were still given a reasonable opportunity to shoot the flight birds which came through between the first and middle of November. However, it is a grave question whether or not the season on woodcock throughout the United States should be closed for a few years. The whole subject comes within the scope of the Federal migratory bird law, and undoubtedly the Federal authorities will take some action on the woodcock question within the next year.

### Ducks.

Black ducks and wood ducks are reported as increasing in all sections of the State, and have nested along the shores and on the inland lakes and ponds. Years ago it was a common sight to see large flocks of these ducks in all parts of Massachusetts, and they are surely coming back, due in a large measure to the protection given them by the migratory bird law. At all seasons of the year, from all localities along the coast, come stories of large flocks of ducks. Many persons who were sceptical as to the effect of the Federal law have now come to realize its value and are loud in its praise. At the game farm at Sandwich 22 wood ducks were raised this year.

## Mallard Duck.

The mallard duck still presents a problem in the breeding of game birds. The desired end is the production of a duck of habits sufficiently wild to insure breeding in the open when liberated. It is a question whether the pure wild mallards, though bred for several generations, will lay enough eggs to justify the expenditure of the money required to breed them. It is likewise a question whether a crossing of the wild and semi-wild types will produce the desired bird. To-day a large number of the ducks have become quite tame before being distributed, and grow tamer after liberation. This is due largely to the way the birds are handled by the persons receiving them, who, finding them beautiful and interesting, too often pet and overfeed them, with the result that they will more and more come to recognize a feeding hour and place instead of wandering off to become real wild ducks.

The Commissioners are alive to the situation and to the type of bird required if this work is to be a complete success. If a satisfactory bird cannot be produced, the breeding of them will probably be discontinued entirely. No doubt the present semi-wild mallard, so called (which originally came from the pure wild stock), could on reservations and shooting preserves be handled by expert keepers so that they would be sufficiently wild for sporting purposes; that is to say, would be good flyers and could be "driven" to the gun. This of course is impracticable in any system of State-wide distribution to the rank and file of applicants, and as a result a wilder duck must be developed. The plan of putting out more and more flocks of the semi-wild birds on the various State reservations will be continued in order to observe whether these birds, when left alone and compelled to shift for themselves, will rear broods sufficiently wild so that they will not fall an easy prey to the hunters and vermin.

## Quail.

The spring of 1917 was a very poor breeding season for quail. When the birds were nesting the weather was cold and rainy, and without doubt many young birds in the early broods per-

ished; but good broods came from the second hatch, and when the shooting season opened, November 1, the quail were quite plentiful on Cape Cod and along the southern boundary of the State.

Essex county has already been closed to quail shooting for two years, and the Legislature of 1917 closed Hampden and Middlesex counties likewise for a period of five years. Just what the effect of this action will be it is hard to say. Most of the quail that are destroyed are killed by the deep snows and heavy crust of severe winters, and not by the gunners, as is generally supposed.

With a few good breeding seasons the department feels confident that in such sections as provide the proper environment the quail will be plentiful again.

It was not possible to carry out the proposed experiment at Marshfield in trapping up wild quail, holding them long enough to take a clutch or two of eggs, and liberating the birds in time to permit raising a brood in the open, owing to inability to secure a sufficient number of wild birds to make the experiment. However, the plan will be continued during the coming season. It is believed that if this method can be successfully worked year after year it will go a long way toward solving the quail problem. As it is, most of the early-hatched birds perish through the cold and wet of the early breeding season, and the greater part of the birds which survive are of second or third broods. If a reasonable number of birds can be caught up in a given locality, a certain number of eggs collected, and the birds liberated on the arrival of the favorable breeding season, it should result in saving a large number of the young which would otherwise be destroyed, and not affect the number of birds raised in the open.

In other reports the statement has been made that vermin and the rigorous winters are the great menaces to the quail. Every year a number of applications for quail are received from the northern and western parts of the State. Some shipments have been made into these regions, more for experimental purposes, but so far the results have not been satisfactory. It is true that quail in years gone by have been numerous in southern Berkshire, with a substantial sprinkling

of them in such counties as Franklin and Hampshire, but until a thoroughly organized campaign for winter feeding is in full swing, and the birds which may be left in the fall are accurately located and carefully cared for during the long winters of deep snow, it is doubtful whether in these localities the quail will ever be increased in such numbers as will justify the effort and the expense. It is with reluctance that the Commissioners make such a statement, for the reason that they would like to be able to establish this game bird in every part of the State. Just as the pheasants seem to gradually work toward the swamp land and the sections of tall grass along the sluggish waters where they find the maximum protection, so the quail seem to prefer a country of bull briers, scrub oak and pine, and localities of dense vegetation where they can obtain the best possible shelter. To what extent the birds will gradually change by reason of greater care and protection during the winter remains to be seen, but there is no such organized effort to-day as insures much artificial assistance to them.

## Deer.

Reports received from all sections indicate that the deer are increasing in Massachusetts. The open season on deer for 1917 was changed from November to December. As this report is made only to Nov. 30, 1917, statistics of the 1917 season will appear in the next report, which will begin with Dec. 1, 1917.

During the severe winter weather when snows are deep it is no uncommon thing to receive reports of 12 to 20 deer seen in one herd.

The method of killing with a shotgun (which the law requires) seems to be the right thing for a state as thickly populated as Massachusetts. Trolley lines and highways run in every direction, and any other method would without doubt result in many accidents. The small number of accidents which have occurred since the killing of deer has been allowed proves that the method is correct.

The amount paid in 1917 by the State for damages by wild deer was $10,125.21.

*Comparison of Deer Statistics.*

| | 1907. | 1908. | 1909. | 1910. | 1911. | 1912. | 1913. | 1914. | 1915. | 1916. | 1917. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Deer reported as having been seen, | 1,298 | 2,035 | 1,594 | 2,582 | 1,608 | 1,120 | 872 | 523 | 664 | 541 | 635 |
| Seen chased by dogs, | 114 | 120 | 71 | 26 | 10 | 13 | 5 | 4 | 6 | 2 | 5 |
| Seen damaging crops, | 85 | 100 | 227 | 358 | 242 | 220 | 153 | 214 | 237 | 187 | 24 |
| Shot illegally, | 40 | 36 | 49 | 64 | 30 | 23 | 13 | 5 | 4 | 11 | 10 |
| Killed by trains, trolley cars, automobiles, | 25 | 60 | 55 | 50 | 25 | 35 | 14 | 25 | 20 | 14 | 11 |
| Dead from other causes (dogs, drowning, etc.), | 47 | 83 | 82 | 157 | 77 | 126 | 109 | 118 | 76 | 71 | 87 |
| Shot while damaging crops, | 16 | 17 | 198 | 327 | 232 | 313 | 195 | 212 | 254 | 208 | 223 |
| Totals, | 1,625 | 2,451 | 2,276 | 3,564 | 2,224 | 1,850 | 1,361 | 1,101 | 1,261 | 1,034 | 995 |

Summarized, the facts given in the above table show: —

| | 1907. | 1908. | 1909. | 1910. | 1911. | 1912. | 1913. | 1914. | 1915. | 1916. | 1917. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Live deer reported, | 1,497 | 2,255 | 1,892 | 2,966 | 1,860 | 1,353 | 1,030 | 741 | 907 | 730 | 664 |
| Dead deer reported (exclusive of those taken in open season), | 128 | 196 | 384 | 598 | 364 | 497 | 331 | 360 | 354 | 304 | 331 |
| Total, | 1,625 | 2,451 | 2,276 | 3,564 | 2,224 | 1,850 | 1,361 | 1,101 | 1,261 | 1,034 | 995 |
| Notices issued relative to dogs chasing, | 27 | 37 | 30 | 3 | 14 | 24 | 2 | 8 | 10 | 16 | 5 |
| Court cases: — | | | | | | | | | | | |
| Dogs chasing deer, | 5 | 2 | 5 | 7 | – | 8 | 4 | – | – | 3 | – |
| Killing, hunting, wounding, selling, | 6 | 15 | 22 | 25 | – | 14 | 22 | 11 | 13 | 5 | 14 |
| Total killed in open season, | – | – | – | 1,281 | 1,270 | 1,231 | 1,596 | 1,312 | 1,105 | 1,052 | –[1] |

[1] See next year's report.

Deputy feeding birds in winter, Berkshire County.

## Winter Feeding of Birds.

During the past winter the Commission has furnished grain and chaff, to the value of $600, to numerous persons throughout the State to feed the wild birds. The amount was thus limited, and the people who put out the grain immediately, without waiting until the time when it was needed, were unable to obtain second allotments. Persons receiving grain for distribution should bear in mind that it must be put out only during the severe storms of the winter, when it will do the most good, and that it is a great mistake to distribute this grain prodigally the moment it is received. The idea is to help the birds *keep alive* in those annual crises. To insure this alone in all parts of the State will require a far greater sum than the Commission has ever expended. Plans for the coming winter contemplate the collection of a supply of waste grain to be held in readiness to put out as soon as the snow comes. The amount of grain will necessarily be restricted owing to limited funds and to the increase in price. For this reason persons are requested to use it sparingly, and to put it out only when the birds are actually in great need. Reports from those who are doing this work independent of the department will be welcomed. A record of such persons is gradually being built up in an effort to organize the forces all over the State.

Farmers are encouraged to leave shrubs and grain along the fences for the birds to feed on during the fall and winter. By planting grain at the cost of a few dollars in places accessible to the birds, and leaving the crop unharvested, farmers can do much toward saving many birds. The sportsmen can show no greater appreciation of the opportunity to hunt on these lands than by compensating the farmers for this work.

The building of winter feeding stations, which should be located in places protected from natural enemies and from weather conditions, is urged. A most satisfactory way is to construct, after the snow has been cleared away to the bare ground, a lean-to of boughs or trees, which should so cover the ground that a fairly good-sized area will be left free from snow. Food such as grain, hay, chaff, barn sweepings, straw and grit may be put in the cleared space. Plenty of room

should be given so that the birds may have easy exit if attacked by predatory animals. Small shelters may be made by piling brush against fences, being sure to leave openings at either end.

There is still another line which might be developed at little cost, but to great advantage. There has been much talk for a number of years of planting "food-bearing shrubs and trees" for the birds, but very little of this talk has been put into practical operation. It has been noticed that in portions of Massachusetts and New Hampshire, locally known as the abandoned farm country, there are numbers of old apple trees, and that partridges especially feed very heavily on the fruit. Many of these trees are old and dying, and but few young trees are coming along to take their places. There are, moreover, but few trees, widely scattered. This suggests the idea that there is no logical reason why apple or other trees which retain their seeds or fruit through a large portion of the winter could not be planted in practically every likely bird spot in New England. Most of these covers to-day are grown up to worthless vegetation of one kind or another.

### Enemies to the Birds.

The enemies to the birds seem to be almost numberless, but three now receiving special attention may be enumerated as follows: (1) the pot hunter and unnaturalized hunter who has not learned the lesson of the value of bird protection; (2) the domestic hunting cat; and (3) the various predatory vermin.

#### *Unnaturalized Hunters.*

The offender who gives most trouble to the deputies is the foreign-born person, particularly the Italian immigrant, who, either wilfully or in ignorance of the laws protecting the birds, seeks to apply here the methods of the chase to which he has been accustomed in his own country. The laws of Massachusetts now forbid all aliens, excepting those who own taxable property of at least $500 value, owning, having in possession or using a rifle or shotgun within the Commonwealth. As a result the pursuit of wild life is carried on assiduously by these men in such ways as trapping with horsehair nooses; liming trees; the use of string and spring traps such as the "arca;"

and other methods in addition to the use of firearms. In the annual report for 1916 a photograph was shown of the confiscated guns which had been taken from persons under the alien law (chapter 240, General Acts of 1915). Many additional guns have been taken up during the past year.

Your Commissioners have no special grievance against the alien hunters. Many of them will develop into good citizens; but it is felt that, until they have assimilated American ideals, and until they appreciate the importance of protecting wild life, they should be held in check. They must assume the obligations of citizenship and must take advantage of the opportunity to adjust their old ideas to new conditions.

### *Domestic Cat.*

Mr. Charles A. Wilson in the "Conservationist" asks this pertinent question: "Shall we have cats in uncontrolled numbers, or shall we have crops?" Upon analysis the question resolves itself into whether we shall have cats, or the birds without which agriculture would prove a failure. It is for this reason that the uncontrolled hunting house cat should be systematically and effectively kept in subjection.

The damage caused by cats is much greater than is ordinarily believed. Large numbers of wild house cats roam the woods and fields in their search for prey. Rarely can one traverse a few miles of country road without noticing stray cats prowling through the fields. Many of these lead a wholly independent existence; others, insufficiently fed and cared for at home, are partially dependent for food upon their own hunting powers. Their number is constantly being augmented by an excess production for which homes cannot be supplied. Particularly in the summer colonies along the seashore the uncontrolled cat is at its worst. At times cats may abandon good homes and lead a free-living existence during the summer, but the great proportion of stray cats are those which have been left behind by the summer cottagers on their return to the cities in the fall. These animals, left to secure their own living, readily resume the wild, bloodthirsty habits of their ancestors in preying upon birds and other wild forms. On Marthas Vineyard, especially, stray cats abound, and on the

heath hen reservation continual warfare has been maintained by the superintendent.

Mr. Edward Howe Forbush, the State Ornithologist of Massachusetts, cites several instances where the bird population has been destroyed by cats on small islands. At Monomoy Point on Cape Cod a colony of least terns was nearly exterminated by cats from the fish shanties. On Muskeget Island a large colony of breeding gulls and terns, estimated at 45,000 birds, was seriously threatened by cats. The situation on Muskeget has been improved by the enactment of chapter 40, General Acts of 1917, passed on recommendation of this Board, which forbids any person, under penalty of a heavy fine, to take or cause to be taken to this island any cat, or to have a live cat in possession or at large on the island.

The Massachusetts Fish and Game Commission is making an energetic plea to the fishermen, cottagers and other people to consider well the serious danger resulting from the importation and subsequent abandonment of cats. Throughout the country there have been movements toward suppression of this dangerous enemy of bird life. Various methods in the form of moderate license fees, coupled with effective measures of restraint and elimination of stray animals, have been proposed in Massachusetts, but as far as legislative measures are concerned no action has been taken, and the cat is allowed to pursue unmolested its nefarious course of destruction. The situation is well summarized by Mr. Edward Howe Forbush in a special report upon "The Domestic Cat."[1]

> The evils connected with the unrestricted liberty of the cat can be abated only by reducing the number of cats to a minimum, limiting breeding, destroying superfluous kittens at birth, restraining or confining cats kept as pets and as ratters (particularly at night and during the breeding season of the birds), quarantining cats in cases of infectious diseases, and destroying all stray and feral cats, wherever they may be found.

## Vermin.

Superintendents of the State game farms have for years waged warfare against the various forms of vermin which interfere seriously with the artificial propagation of game birds.

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[1] Economic Biology Bulletin, No. 2, Massachusetts State Board of Agriculture.

Where a large number of birds are concentrated in a small area, predatory vermin find easy opportunity for destructive work if constant vigilance is not maintained.

Vermin are those forms of animal and bird life which, because of their predatory nature, serve as a natural check upon the increase of game and insectivorous birds, and tend, under abnormal conditions, to multiply beyond the balance of nature. They primarily include the smaller mammals and birds of prey.

Vermin may be grouped into four classes: (1) wild mammals, such as squirrels, weasels, skunks, foxes, raccoons, muskrats and mink; (2) semi-domestic mammals, such as rats, cats and ferrets; (3) predatory birds, those belonging to the hawk and owl families, including the sharp-shinned hawk, Cooper's hawk, red-shouldered hawk, red-tailed hawk, goshawk, barred owl, great horned owl and snowy owl; and (4) destructive birds of various types, such as the crow, English sparrow, starling and blue jay.

The destructiveness of these natural enemies is much greater than is ordinarily realized. There is no closed season for these hunters, who operate three hundred and sixty-five days (and many nights) in the year. The relative amount of damage by the various classes of vermin is difficult to estimate, as it varies with abundance and locality. Perhaps under natural conditions the predatory birds are the chief offenders, whereas on the small reservations it is rats, cats and weasels which are the important enemies. The fourth class, destructive birds, though more or less of a nuisance, do little damage to the adult birds, but destroy the eggs or young.

The bounty system favoring the destruction of designated species is time-honored, but in the light of present-day knowledge its inefficiency and harmfulness are strikingly manifest. Experience has demonstrated that in nearly every instance where bounties, particularly upon predatory birds, have been offered, *all* birds of that class, beneficial as well as harmful, have been taken. Constant vigilance is necessary to prevent extensive fraud in claiming bounties, not to mention the expense contingent to satisfying claims.

### *Squirrel.*

Of the two species, the red is a greater nuisance and more destructive than the larger and better-mannered gray. Their activities are for the most part limited to destroying eggs. It is a question whether the damage is not more than offset by the hunting they afford. If they become too numerous or acquire bad habits they should be thinned out, but otherwise left alone.

### *Weasel.*

Weasels are undoubtedly the worst menace, for their pelts are of little value as fur, and they are not taken by the trapper. To-day very little is being done to keep this animal in check, and doubtless it will require greater attention in the near future, and ways will need to be devised to reduce its numbers.

### *Skunk.*

To birds and chickens the skunk is an ever-present source of danger, as its work is most constant. All skunks on or near any game preserve should be eliminated.

### *Fox.*

This animal cannot be given a "clean bill of health," but its usefulness as a destroyer of wild mice and moles is greatly in its favor. The value of the pelt amounts to a bounty on the animal's head. This, coupled with the large number of fox hunters, will insure keeping the numbers in bounds.

### *Raccoon.*

Raccoons prove a source of considerable danger to the young birds and eggs, and are especially difficult to control owing to the fact that they are capable of climbing rather high fences.

### *Mink.*

Mink are destructive, bloodthirsty creatures which destroy merely for the love of it. They are caught along the brooks by setting steel traps under the water near the side of the stream, baited with an apple or meat on a stick, so arranged that the animal is obliged to pass over the trap.

### *Rat.*

The general idea is that rats are confined to thickly settled communities and live only in houses and outbuildings. However, it is a fact that larger numbers of them roam the countryside. They show great adaptability to surroundings, and soon become at home in the open. They are particularly destructive to eggs and young birds.

### *Hawks.*

The sharp-shinned, red-shouldered, red-tailed, and the Cooper's hawk, particularly destructive to bird life, should be absolutely barred from reservations. The rough-leg and marsh hawks, which are usually condemned indiscriminately, should not be destroyed unless they are known to be more harmful than beneficial. The goshawk, a winter visitor in the State, is the most deadly of all, and should be killed on sight. Other species of hawks should be protected, as they do considerable good and seldom trouble the birds. The one exception is the marsh hawk on Marthas Vineyard. Here the land is so closely covered with a dense growth of scrub oak and other brush that mice are difficult to capture, and thus these birds have been compelled to turn to more easily captured prey, — the heath hen. In one instance the nest of a marsh hawk contained the remains of one flicker and eleven heath hen chicks.

Some States have enacted laws placing bounties on hawks and owls because these birds as a class bear the reputation of robbing hen coops. The killing of hundreds of birds has followed without regard for their habits and value, with the result that in a comparatively short space of time these localities have been overrun with mice and other vermin. It was found by investigation that a majority of the hawks, with the exception of the above-mentioned species, do more good than harm, and that their detrimental influence on game birds is slight as compared with the immense amount of good accruing to the agricultural interests.

The inroads of the Cooper's and the sharp-shinned hawk caused a considerable loss at the East Sandwich Game Farm. Two methods of offsetting their attacks have been pursued:

(1) with shotgun, necessitating continual watchfulness on the part of the hunter; and (2) with traps placed on poles situated near the enclosures. It is customary for hawks and owls to alight on an object before swooping down upon their prey, and by placing traps with jaws wound with cloth on high roosting places it has been possible to capture a number of these predatory birds.

*Owl.*

The barred owl, great horned owl and snowy owl are to be classed among the injurious birds. Screech owls should be protected at all times.

*Crow.*

Crows are mischievous villains, but their general extermination is not recommended. As destroyers of eggs of pheasants and other birds they do considerable damage.

*Blue Jay.*

The blue jay is a mischievous bird, and, like the crow, destructive to eggs, although probably to a lesser extent.

*Starling.*

The starling, introduced into New York State a few years ago, is rapidly increasing, and is gradually spreading over Massachusetts. This bird bids fair to become as great a pest as the English sparrow, and possibly more destructive, especially to the song and insectivorous birds.

*English Sparrow.*

The European house or English sparrow, which is now firmly established in this country, mobs the native birds, and breaks up their nests and eggs. Because of its filth and destructive habits it has been styled an avian rat. Systematic campaigns in various sections of the country have already given proof that this pest may be held in subjection in the same manner as rats and mice. A campaign is not only justified but highly necessary if crops are to be protected and native birds encouraged. It is possible that this species may be utilized as food, as in Europe.

## Spraying.

Numerous reports have been received concerning the death of birds by poison from the spraying of trees. In the campaign against the gypsy and brown-tail moth and other insect pests there has been a wholesale spraying of fruit and other trees by the State and by individuals. Arsenate of lead, a deadly poison, has been most commonly used. Unquestionably birds have died from eating fruits and berries covered with this spray, but probably in a much less number than is commonly supposed. The chief trouble arises from the fact that people are in the habit of spraying at the wrong time of year, when the damage is greatest to the birds and the spraying of least benefit to the trees. State Forester Frank W. Rane recommends that for the protection of the birds and to achieve best results the spraying by individual citizens should be done when vegetation has developed sufficiently to hold the poison (varying somewhat with the locality and season), and when insects are small, the idea being to spray as early in the season as possible after vegetation has started.

## Bird Colonies.

The Commission has been investigating the colonies of birds along the coast, particularly the breeding places of the terns. The condition of the tern colonies, especially the rare least tern, has shown no improvement during the year, indicating the need of more stringent protection. The most famous of the tern breeding places are Weepecket Islands and Penikese Island in Buzzards Bay; Muskeget Island; the south shore of Marthas Vineyard near Katama Bay; and Monomoy Beach at Chatham. These colonies have suffered severely from the inroads of cats and skunks. The colony at Monomoy has received especially serious damage. The Commissioners' estimates for next year ask for an appropriation to protect these colonies by patrols who, prior to the breeding season, will rid the localities of vermin before the birds arrive, and then guard them from vermin and from human interference. The maximum opportunity will be afforded the birds to propagate in favorable surroundings.

## Dogs.

The dog question has taken on a more hopeful appearance. The problem of the self-hunting dog will always be present. While the difficulty of keeping dogs continually tied, when their natural instinct and craving is for the woods and fields, is fully appreciated, nevertheless, for the sake of the breeding of ground-nesting birds the cruising of dogs during the closed seasons should be checked in so far as possible. Moreover, there is a great effort being made to revive the sheep-growing interest in the Commonwealth. While perhaps the damages by dogs may be overstated at times as the reason for the decline of the industry, it is a fact that dogs do much damage, — usually the cur-dog, having collie or bulldog blood in him. The nation is at war. One of the ways to win that war is by the production of food. Thousands of acres of land in this State can produce sheep where none are raised to-day. If it is necessary to put some restrictions on all dogs in order to control the bad ones, it is believed that the reasonableness of it will be apparent.

The Legislature of 1917 enacted chapter 102, Resolves of 1917, whereby in the interests of sheep raising in Massachusetts a commission was appointed to make a thorough investigation of the dog problem and formulate the necessary recommendations for a new dog law. This commission was composed of Wilfrid Wheeler, Secretary of the State Board of Agriculture; William C. Adams, Chairman of the Fish and Game Commission; Arthur Seagrave, Assistant Attorney-General, and Judge Sanborn G. Tenney of Williamstown. This commission is to report its findings and recommendations to the Legislature of 1918.

## Fur-bearing Animals.

Among the fur-bearing animals indigenous to Massachusetts, which are of value for their pelts, may be mentioned the raccoon, mink, skunk, muskrat and fox. Of these the muskrat perhaps has been too much underrated, and therefore it has not received all the protection to which by right it is entitled. By adequate protection and artificial propagation a valuable industry may be established.

## Bird Farms and Fish Hatcheries in General.

The opinion is more or less general that the rearing of fish and game birds is a comparatively easy matter. Just the opposite is true. Few occupations call for more patience, perseverance and closer attention to detail, and few have more latent possibilities of failure. A sudden change in temperature may destroy a great quantity of eggs or young fish. A storm or a heavy rain may kill a large number of young birds in the field. More than once have the superintendents seen many days of hard work and care come to naught in a brief time through causes entirely beyond their control.

### *Changes in Operation.*

In the past the breeding of several species of fish or game birds has been carried on at each station. Likewise two or more stations have been producing like species of fish and game. Your Commissioners have come to the conclusion that wherever possible the breeding of a certain species should be consolidated in that station most adapted to the work, and that so far as practicable the superintendents should specialize in breeding a particular species. Many economies are likely to result. This plan has been put into operation as set forth in the reports on the several stations. Further changes will be considered, the object being to bring each plant which the State now owns up to the highest point of efficiency before establishing others.

### *Distribution.*

When the stock is ready for distribution new conditions arise. To-day most of it is distributed on applications filed throughout the year. Lists are made up at the central office covering the names and shipping addresses of the applicants. These are sent to the stations, and at the proper time the distribution starts. Believing that the public should have more advance information as to the conditions under which stock may be received, all application blanks have this year been redrafted and standardized. Heretofore one form was used for a large number of species. Now there is a form for

each, carrying the appropriate information. The Commissioners do not make definite promises to any one to ship stock. It is impossible to know in advance how much will be available. Very often at the last minute cancellation of orders already given becomes necessary. It is desired that the public become fully acquainted with these problems, that they may appreciate how many conditions may arise to defeat the desire of the Commissioners to supply each applicant.

Stock is delivered to the applicants at the railroad stations, they to assume the expense of liberating or planting it. While it is aimed to have a deputy oversee the final step, that is many times impossible. Very full instructions as to planting are given in a pamphlet sent in advance of shipment.

The ideal method would be to do away with individual applications entirely, and for the department to distribute the stock in those waters and places best adapted to it, all work to be done by a corps of trained assistants. The cost, however, would be prohibitive, considering the sum now available for this branch of the work.

### *Work at the State Game Farms.*

*Marshfield State Bird Farm.* — Until last fall this farm was operated at two locations. The stock of adult semi-wild mallard ducks was maintained on an area of bog land owned by Superintendent Sherman at a distance of one mile from the station proper. Here the birds were wintered and kept during the breeding season. While these birds were given a certain amount of freedom, they were wing-clipped and kept under sufficient restraint to enable the superintendent to collect the eggs. Under these conditions the mallard is a more or less promiscuous layer, very often dropping its eggs in the water, with the result that vigilance is required to insure the collection of all the eggs daily, and to see that they are kept in proper condition.

The main part of the bird farm is located near the Marshfield railroad station on a tract of about 50 acres. On March 1, 1917, a lease of this land was taken by the Commissioners for a period of three years with an option of purchase. This was preliminary to consolidating the two branches of the work

on this tract. At this farm a large duck yard was built, extending nearly the full length of the tract and parallel with the railroad track, in order to take in a large portion of the meadow land. A never-failing brook runs through the meadow, and by partially damming it up a sufficient amount of water is obtained to give the ducks all they require. A shed 40 by 16 feet, open to the south, was provided to house the ducks in the very cold weather. The floor was covered with a foot of straw and a bath provided for the ducks, where they would have sufficient water during the coldest season. In this pen was confined the flock of wild mallards acquired in the early winter, — all wild, trapped birds shipped from Louisiana. Every effort was made to give them as favorable conditions as would be possible through the winter. The birds were kept in this same large enclosure throughout the spring, and though every effort was made to put them in a good laying condition, no eggs were taken from the flock. While the result was disappointing, the experiment confirmed the opinions of various breeders that these wild ducks will not breed in captivity the first year. During the summer and fall they were kept in the large pen with access to the house if they desired it, but it was found that they stayed outdoors altogether after the weather began to break up.

Owing to the late and very cold season the flock of semi-wild mallards did not lay the usual number of eggs, with the result that the whole year's breeding operations may be described as unsatisfactory. After the flock had practically finished laying, a number of ducks were allowed to locate their own nests in the meadows, and several of them successfully raised small broods.

One of the difficulties in breeding pheasants and quail, and a very great part of the expense of production, lies in the fact that hens must be used entirely to incubate the eggs. Therefore it is necessary to have for this purpose in the spring a large flock of hens at each station. Plans were laid in the fall to hatch at Marshfield a large number of chicks, mostly barred Plymouth Rock, white Plymouth Rock and Rhode Island Red, and force the growth in the brood house. In order to further this project, and to provide additional facilities for rearing the

ducks (which will be mentioned later), a cooling house 200 by 15 feet, divided into 20 pens 10 by 15 feet, one to hold the heater, was constructed. This house is built in sections so that it can be relocated if at any time it should be considered advisable. It has a board floor, plenty of windows and a small heating system which enables the superintendent to keep the house warm or cold, as he desires. Here a large number of chickens were raised during the winter, and a substantial number of them were sent to the stations breeding pheasants. In addition, a very substantial amount of stock undesirable for hatching operations was sold. Owing to the rapidly increasing cost of grain it was decided not to repeat the operation this fall, but to try the experiment of renting setting hens when needed. The house, therefore, will be used during the coming winter to care for the entire stock of ducks, both wild and semi-wild, so that they may be in prime condition to lay next spring.

As part of the plan of consolidation the section of the farm heretofore located on Superintendent Sherman's land has been abandoned, the wire fences taken down and transferred to the main yards, and all the semi-wild stock transferred to the main plant. This reduces the time hitherto lost in traveling back and forth, in the handling of supplies, and gives the superintendent opportunity for closer supervision. In view of the excessive cost of grain the flock has been reduced to 450 birds, — 200 wild and 250 semi-wild mallards. Duck rearing has been discontinued at all the other stations (with the exception of wood ducks and black ducks at the Sandwich Bird Farm), and all the work consolidated in this farm.

Considerable improvement was made in the grounds around the buildings, a walk and flowerbeds being laid out, and a substantial amount of grading done.

*Sandwich Bird Farm.* — The Sandwich Bird Farm was originally situated on a bowl-shaped piece of land. In the bottom of the bowl some farming was done, and the pens were located in a heavy growth of red cedars and pitch pines around the sides of the bowl. The pens were so built as to take in most of the standing trees.

The rim of this tract was through level country, part of

which was cultivated in a growth of buckwheat, and on the rest of it were scattered coops. On this level stretch most of the hatching boxes were located, as well as the small pens containing the hens with broods of young quail.

Realizing that the existing conditions at this farm could be much improved upon, it was decided in the fall of 1916 to seek a new location, and in the spring of 1917 the bird farm was removed to a comparatively level stretch of country about one-half mile from its former location, containing from 85 to 100 acres, open for the most part, with groups of trees, as well as a complete fringe of thickets, shrubs and trees bordering the springy swamp land of the brackish marshes. These marshes, through which runs a brook or tide creek fed by springs from the adjacent swamp land, border fully one-half the upland of the entire bird farm. The swamp land gives ideal rearing places for wood ducks, and the adjoining fringe of thickets offers the best of inducements for the young quail as they come to maturity. On the westerly side of the farm, and partially enclosed by it, is a fine pond of clear water containing 15 or 20 acres, with two wooded swamps connected with it, all of which goes toward making ideal conditions for ducks and quail.

The soil as a whole would be called poor, although certain sections with judicious use of fertilizing material will grow any crop, and the poorer portions will raise fine crops of buckwheat.

This open pasture land, with the small shrubs and bushes scattered more or less throughout the whole area, taken in connection with the several strips and areas of buckwheat, makes the conditions for young quail nearly perfect.

The quail breeding coops have been located on open land in rows, now so situated that the superintendent can survey most of his station at a glance, and is better equipped to fight vermin. The idea of relying on the natural growth of vegetation as a protection to young birds has given way to some extent to the plan of growing this cover. The result is that tracts of the new farm are being cultivated and planted to timothy, clover, buckwheat and corn. In addition, the natural groups of bayberry and blueberry bushes were utilized, and for controlling the young quail and bantams for the first week a

wire netting (half-inch mesh) a foot and a half wide was staked out on the ground to make a pen about 30 feet in diameter. These pens were so arranged as to take in the clumps of bushes, and each bantam hen with a flock of young quail was placed in such an enclosure. Later this wire enclosure was removed, and the boxes containing the setting hens were placed on or near the cultivated areas and the young birds were allowed to work around through it. By cultivating the protective vegetation the ground will be sweeter, the vegetation can be made of the most desirable kind, and it will serve two purposes, — protection and a supply of grain.

Most of the farm is upland which makes off to the salt marsh on the northerly and easterly side. On the edge of the marsh the springs above mentioned are being collected into open spaces for duck pens. These pens make ideal breeding places for the wood duck. It is also a most favorable location for continuing experiments in breeding the pure wild black duck.

The work at this bird farm has always been considered experimental, for the reason that it has not as yet been demonstrated that young quail can be raised with the same degree of ease as young pheasants. It is difficult enough to raise large numbers of young pheasants, but even greater is the problem with the quail. It is with great satisfaction that your Commissioners say that the losses in the past year have been due not so much to infertile eggs or failure to rear a good percentage of the young, as to losses of the adult stock due to the inroads of vermin and other causes. It is surprising how many casualties due to most unexpected causes can take place in the brood stock of a bird farm.

One time a great horned owl found an entrance in the top of a large wire-covered winter yard, where a tree swaying in the wind had opened up a small space between the wire and the tree trunk. Through this hole he came at will, and before it was known, he had killed two-thirds of the flock.

Another time a common small screech owl (protected by law for its desire to destroy only mice, insects and other small animals) entered one night through the top mesh (2-inch) and killed five adult quail, eating only the head and neck. There

he was sitting in the morning, blinking at the mischief he had done.

Once fifteen quail had been placed temporarily in a low down run. The next morning a Cooper's hawk had succeeded in killing ten of them by reaching through the 1-inch meshes on the sides and top, catching them as they struck against the wire.

One season in July, as the quail were laying in good shape, a family of weasels suddenly showed up, and the next morning over twenty laying birds were found dead, and about as many more the next night. The six weasels were all shot or killed inside of three days; and so it goes.

Below is given a record of the vermin destroyed at the farm in 1917. At first glance one might say, "Not much of a score," but when it is considered that certain of the most ferocious ones are killing something every day or night of the year, it changes matters. They know no closed season or bag limit. It is safe to say that the seven great horned owls in the course of a year, allowing one feed per night, would destroy over 2,500 game birds or animals, including muskrats, skunks and ducks. The 26 Cooper's hawks would destroy in a year over 10,000 birds ranging from a partridge down to a bird the size of a robin. The goshawks are specially fond of grouse. It is safe to say that if these hawks, owls, weasels, rats and black snakes had been allowed to live it would make a yearly loss of 25,000 birds ranging from the size of a duck to the smaller birds.

This year the station suffered from an attack by a colony of weasels, and when the work of extermination was finished, seven had been killed. This colony of weasels, which appeared to be one family, although fully grown, was seen one day traveling together along the springy margin of the marsh in close proximity to some wood and black ducklings, and not very far from the coops of breeding quail. Every available trap was set and a dozen new ones were bought besides. Considerable anxiety was felt for several days until they began to get into the traps, and until all had been caught. This was the only bunch that came together and was destroyed before they did any damage, so far as is known. The weasel

is probably the most persistent and deadliest foe to the quail farm. More has been said in regard to this animal as vermin in another part of this report. He is a most deadly enemy, the most difficult to handle, and appears to be on the increase. With the relocation of the farm in more open country, with the resulting better opportunities for fighting such causes of destruction, there will be a decreasing death rate from such causes. Hawks and owls are also great offenders. In the course of a year a surprising number are killed off. Records for the year 1917 show the following: —

A total of 54 hawks and owls, including —

| | |
|---|---|
| 2 red-tailed hawks. | 1 broad-winged hawk. |
| 1 red-shouldered hawk. | 1 rough-legged hawk. |
| 2 goshawks. | 7 great horned owls. |
| 26 Cooper's hawks. | 5 short-eared owls. |
| 1 marsh hawk. | 1 screech owl. |
| 7 sharp-shinned hawks. | |

The following animals were also taken: —

| | |
|---|---|
| 13 skunks. | 31 chipmunks. |
| 26 weasels. | 2 red squirrels. |
| 99 rats. | 8 black snakes. |

In the breeding of quail much the same methods as heretofore are being followed. In winter the adults are kept in large open pens with heaps of brush for shelter, not so much against the rigors of winter as to afford them seclusion which they much desire. In the breeding season they are kept in smaller pens, one pair to each pen. The eggs are collected regularly, each being marked with the date of taking and the number of the pen. They are hatched under bantam hens, which have been found to make the best mothers. At a very early age the young birds are placed in the open with the bantam hen in the sheltered places heretofore described, aiming to give them as much freedom as possible while still keeping them under reasonable control. In view of the fact that the birds are liberated when a little more than half grown, it is impossible to clip them. This need of considerable range and the lack of clipping often makes them hard to handle, but

rapid progress is being made in the plan of giving them considerable liberty and of trapping them up when it is desired to make shipments.

The breeding of the wood duck is a most interesting phase of the work, and results were better this season than heretofore in spite of the fact that the transfer of the bird farm interfered with several pairs. From 44 that hatched 22 were raised. If a sufficient number of these birds can be raised to justify the expense of production, the Commission will have a valuable bird for propagation purposes. The wood duck at one time bred in this State in large numbers, and a substantial number still breed here each year. The drainage of the swamps for cranberry bogs and other reclamation purposes, and the rapidity with which ponds have been built up with summer camps, have all combined to restrict the breeding area of the birds. However, there is still a large area over which they might breed if the numbers could be substantially increased. The object is not only to study the production of the birds under artificial conditions, but to see to what extent those so reared may be distributed in favorable localities. So far as is known these ducks would all migrate during the winter. But it may well be that some of the artificially propagated birds may be induced to winter in specially favorable localities, where special artificial conditions such as open water and shelter are maintained.

The breeding of black ducks has been conducted on a limited scale. This work has consisted mainly in keeping a number of pairs of the pure wild stock clipped and in substantial sized pens where they have plenty of water and seclusion. The transfer to the new location (where most favorable spots are available for this work) was made too late last spring to construct the pens which are desirable for them. This work was started the past fall, and by another breeding season should be sufficiently completed to make available a full and practical test.

*Sutton Game Farm.* — No substantial changes in the station were made in the past year except to enlarge some of the brood pens. During the early spring considerable work was carried on in blasting out the numerous stumps which stud

the main part of the station. The removal of these has done much to improve the general appearance. With it considerable grading was done. The pheasants and ducks were reared in the usual localities.

In line with their belief that the activities at the various stations should be consolidated, and that each species of bird should be reared on that range most adapted to it, the Commissioners are considering the removal of the bird-rearing activities from the Sutton Game Farm and discontinuing the breeding of game birds at this station. The land is so broken up and the colonies of young birds of necessity so scattered that the results of the work have not been considered sufficient to justify the continued expense. It is planned to ship the mallards to the Marshfield Bird Farm and the pheasants to the Wilbraham Game Farm, thus furthering the plan of consolidation. The facilities for rearing ducks are very limited, and it is believed that unless all of the game birds handled can be produced at the stations on a comparatively large scale, the department will not be practicing those economies which are necessary in order to justify the work from a business point of view.

*Norfolk State Bird Farm.* — The position of the Board relative to the mallard duck has been stated in the general discussion of game. Late in the past summer, after viewing the situation carefully, it was concluded that until a more satisfactory type of bird could be produced it would be advisable to limit the breeding of the mallards to one station. The most complete equipment for the purpose was located at the Marshfield station. Another factor was the rapidly increasing cost of feed. The ducks are heavy feeders, and it was felt that the existing price of grain represented another strong argument in favor of the consolidation. In line with this it was deemed advisable to suspend the operations at the Norfolk State Bird Farm. The young birds produced were distributed, and likewise the adult stock. The poultry was shipped to the Sutton Game Farm and the general equipment stored in the camp occupied by the superintendent. The entire tract of land formerly occupied by the bird farm, together with other parts of the hospital grounds, offers an attractive site for a bird reser-

Old barns at Wilbraham Game Farm, on the place when the property was purchased by the State.

New barn at Wilbraham Game Farm, constructed in 1917. Shows also the new cement incubator house.

vation, and in the future it is planned to liberate a substantial number of birds each year in this locality. The marshes furnish an admirable breeding range for ducks, and should be a good place to continue experiments as to whether the semi-wild birds will produce still wilder offspring when breeding on such a natural range.

*Wilbraham Game Farm.* — The past year at the Wilbraham Game Farm has been one of notable progress. The completion and use of a new concrete incubator house; the construction of a new type of rearing-coop; a new ice house built as an extension to the carriage house; the moving and remodeling of the former shop into a bungalow; and the erection of a large modern barn are among the improvements that have made this station an up-to-date game farm.

It has been learned that in order to secure the best results the young pheasants must be reared on cultivated land, and as rapidly as possible the land has been gotten under cultivation. About 10 acres were plowed and planted this year, giving now about 40 acres of cultivated land.

The question of labor was quite a problem during the summer, and this, coupled with the cold wet weather in May, and the extremely dry spell during July and August, was an important factor in reducing the output. Much of the time of the regular employees had to be given to work on the improvements, but in spite of this fact the season was the best since the station was established, in 1912. Ringneck pheasants and mallard ducks were the only kinds of birds propagated.

The ducks began to lay about the middle of March, before the snow and ice had disappeared. The pheasants began laying April 6. Three thousand three hundred and seventy eggs were distributed to applicants throughout the State. The young pheasants, as soon as ready for the rearing fields, were placed in the new coops, which proved a great success. The high cost of grain has added a considerable amount to the expense of production.

The new barn replaces the two old ones which were on the property when the State acquired it. This building is located some distance from the house, and is 38 by 48 feet in size, having a high basement with cement floor and walls. The

basement is large enough to take care of 600 to 800 nesting boxes when arranged in tiers of four deep, making it possible to hatch large quantities of eggs at one time. The main floor contains a harness room, a box stall, stalls for horses and a cow, and a storage place for farm tools. The hay loft is of such a size as to permit of holding enough hay to supply all needs of the station. Above this is another compartment which will admirably serve the purpose of a storage place for extra coops and articles used about the farm during the breeding season. It is expected with all its convenient features to add greatly to the efficiency of the station.

During the last winter the employees made up about sixty of the new style rearing coops, and they proved to be the best ever used. They are 4 feet long, 2 feet wide, 18 inches high in front, and 15 inches in the rear, with a cleat fastened on each end to facilitate handling. A movable partition in the center separates the mother hen from the chicks when the young birds are first placed in the rearing field. Later this is removed to give the hen more room at the time the young birds are allowed to run out into the field.

A considerable number of young birds were killed by hawks, particularly the marsh hawk, and by skunks, but the loss from rats has been reduced to a minimum. A persistent war is continually waged against all kinds of vermin.

*Visit of Legislative Committee.* — Last spring for the first time in many years the legislative committee on fisheries and game secured an order to travel, and visited the State game farm at Wilbraham and the fish hatchery at Palmer.

They spent the entire day at these two stations, examining the improvements that have been made during the past few years, and going over the plans for further extension of the work.

The following were the members of the committee who made the inspection: Senator Charles S. Smith of Lincoln, chairman; Senator Charles W. Eldridge of Somerville; Representative Merrill E. Streeter of Springfield; Representative James M. Lyle of Gloucester; Representative Benjamin G. Collins of Edgartown; Representative G. Oscar Russell of Worcester; Representative George Penshorn of Boston; Representative

George W. Bowman of Springfield; Representative John H. Parker of Marlborough and Messenger S. H. Tower of Hanover.

The Commission also had the pleasure, on some of its trips of inspection to the plants under its direction, of having with it some of the members of the Legislature who gained considerable insight into the methods employed by the Commission, and the condition of the various properties owned by the State under its management.

*Game Distribution during the Year 1917.*

| County. | Pheasants. | | | Mallard Ducks. | | | Quail. | | White Hares. | Total. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Eggs. | Young. | Adult. | Eggs. | Young. | Adult. | Eggs. | Young. | | Eggs. | Birds. |
| Barnstable, | 45 | 24 | 20 | 42 | 124 | 66 | – | 23 | – | 87 | 257 |
| Berkshire, | 770 | 288 | 24 | 210 | 336 | 48 | – | – | 18 | 980 | 696 |
| Bristol, | 210 | 54 | 23 | 36 | 21 | 36 | – | 24 | 12 | 246 | 158 |
| Dukes, | – | – | – | – | 50 | 32 | 30 | 24 | – | 30 | 106 |
| Essex, | 195 | 137 | 56 | 132 | 97 | 73 | – | 58 | 12 | 327 | 421 |
| Franklin, | 60 | 160 | 12 | – | 64 | 12 | – | 8 | 12 | 60 | 256 |
| Hampden, | 585 | 216 | 16 | 237 | 80 | 40 | – | 24 | 6 | 822 | 376 |
| Hampshire, | 510 | 176 | 2 | 111 | 143 | 44 | – | 8 | 12 | 621 | 373 |
| Middlesex, | 375 | 109 | 36 | 54 | 115 | 57 | 15 | 48 | 14 | 444 | 365 |
| Nantucket, | 45 | 16 | 8 | 45 | 27 | 4 | – | – | – | 90 | 55 |
| Norfolk, | 165 | 64 | 16 | 42 | 52 | 56 | – | 16 | 12 | 207 | 204 |
| Plymouth, | 135 | 40 | 36 | 30 | 126 | 61 | 30 | 32 | – | 195 | 295 |
| Suffolk, | 45 | – | – | 15 | 8 | – | – | – | – | 60 | 8 |
| Worcester, | 1,250 | 280 | 52 | 159 | 198 | 111 | 45 | 15 | 6 | 1,454 | 656 |
| Other distributions,[1] | 165 | – | – | 15 | 20 | – | 60 | – | – | 240 | 20 |
| Total, | 4,555 | 1,564 | 301 | 1,128 | 1,461 | 640 | 180 | 280 | 104 | 5,863 | 4,246 |

[1] Indicates lots which have been shipped to other State commissions as an interchange of courtesies.

## INLAND FISHERIES.

### Natural Abundance.

Massachusetts possesses many beautiful lakes, ponds and streams capable of producing an abundance of food and game fish, and in most cases but a few of the many thousand acres of waterways are producing anywhere near their maximum or even normal possibilities. Therefore it is important, both in the interests of sport and as a source of food supply, that these latent assets should be developed for the benefit of the public.

In colonial days, when a relatively small population was scattered along the seacoast, leaving the inland waters in their primitive uncontaminated condition, the abundance of both salt and fresh water fish was far in excess of the needs of the colonists, thus giving rise to the fallacy which has been zealously handed down to the present generation, that "nature will always provide an abundance of fish." Even in this era of conservation this mistaken idea is still deeply rooted, especially among the marine fishermen of the shore towns, and can be corrected only by the lesson taught by complete exhaustion of the natural supply, or by the education of that part of the general public unbiased by special opportunities for personal gain.

### Decline.

With the advance of civilization great changes have been made in our waterways. Many times the balance of nature has been overthrown and a new equilibrium established. With the increase in population the coastal streams were first invaded; cities were established on the larger rivers, and various manufacturing industries were likewise scattered along the smaller streams. In order to supply water power numerous dams were constructed, in most instances unprovided with suitable fishways, thus preventing the passage of fish such as the salmon, shad, striped bass, alewife, smelt and white perch up the coastal streams to their spawning grounds. In this way not only has the supply of these fish been depleted, but the sea fisheries have been indirectly affected by the destruction of a food supply which attracted the larger commercial fish to these

shores. Manufacturing wastes and sewage, particularly in central Massachusetts, have totally ruined many streams, and have seriously reduced or destroyed the supply of fish in others by rendering the water unfit for fish life. Numerous legislative measures were enacted in the past, but the decline steadily continued, since these laws were either inadequate, or, as was more often the case, not enforced. Likewise, overfishing has played its part, and in Massachusetts has accelerated the general decline which has been so marked in the Merrimack, Charles, Taunton and Connecticut rivers.

## Artificial Fish Food.

The importance of an abundance of fish food has long been recognized by the Commissioners on Fisheries and Game, who have foreseen the uselessness of stocking the inland waters of the State with the larger species of fish unless suitable means of providing food are at hand. Primarily the productivity of any body of water depends upon the abundance of the microscopic floating life (plankton), for the reason that the small fish are dependent upon this food for their sustenance, and their production depends directly upon the abundance of the microscopic forms in the water. In turn, the larger fish prey upon the small fish, and an abundance of the latter is necessary for the existence of the former. Therefore, in stocking any pond with the larger predaceous fish, it becomes necessary to see that the pond is supplied with suitable small fish in such abundance as to provide sufficient food for the larger species. In certain ponds small fishes, chiefly shiners and minnows, are sufficiently abundant to furnish the larger fish with food, but in others there is a scarcity of these small species. It is proved beyond a reasonable doubt that a greater volume of fish life can be supported in a limited body of water supplied with an abundance of food than in a larger area of water poorly supplied with food forms. For this reason the problem of supplying a suitable artificial food for the larger fish is fully as important as the proper selection of the waters for stocking.

The Commissioners have selected smelt as the most adaptable fish for furnishing an artificial food supply to the larger ponds. So far results of experimental stocking have been especially gratifying in the case of the landlocked smelt.

### Fry *v.* Fingerlings.

Though the convictions of experts differ widely, your Commissioners are of the opinion that wherever possible, fish should be reared to the fingerling size before being planted. The term "fry" includes those small fish which either still carry the yolk sac or have but recently absorbed it, while fingerlings are those ranging from 1½ inches up to yearling size. Fish in both stages are now distributed by the Commission, fingerlings being reared to the utmost capacity of the hatcheries. The fry which are put out are in the nature of a by-product in the rearing of fingerlings, since a greater number of eggs are hatched than the hatcheries have capacity to rear. The main arguments in favor of fry planting are the comparatively slight expense, the greater numbers which may be liberated, and the fact that the instinct of self-preservation is acquired at an early age. The existing prejudice against fry has resulted from improper methods of planting, or lack of judgment in the selection of waters. The great advantage of fingerling planting consists wholly in their being of sufficient size to better protect themselves against their natural enemies.

### Artificial Pools.

An excellent method for the protection of brook trout fry is by building a series of artificial pools in a stream by means of small dams of loose rocks, boards or logs placed a short distance apart. This insures a good water supply during the dry season, protects them from the larger fish, to a certain extent prevents the fry from being swept away by spring freshets, and provides a larger area for food supply. Similar pools may be formed on the larger streams by excavating suitable basins on shaded, wooded banks near the streams, and pumping water through them. If sufficiently large, these pools will provide enough natural food for a large number of fry.

### Yellow Perch.

Not being able as formerly to secure yellow perch spawn from the Federal government, your Commissioners decided to procure their own eggs if possible. After several locations had

been examined, a field station was established on the Ludlow Reservoir (one of Springfield's water supplies). The eggs secured were hatched at the Palmer Hatchery, and 16,000,000 fry distributed to applicants in different sections of the State a few days after being hatched. It is believed that the future supply of yellow perch eggs can be taken from this field station.

Your Commissioners consider the yellow perch one of the best food fishes, since they make a rapid growth and are a splendid pan fish. The striking value of this class of fishes is brought home with added emphasis at a time when the food question has become so acute in this country. The yellow perch and other allied species will more than "do their bit" in helping to relieve the pressing demand for food.

### Chinook Salmon.

Experiments with the Chinook salmon have been carried still farther during the last year, both in regard to establishing these fish in the Merrimack River and in stocking the inland lakes.

Last fall 600,000 Chinook salmon eggs were received from the Oregon Fish and Game Commission, all of which were hatched at the Palmer Hatchery with the exception of 24,000, which were sent to the Sandwich Fish Hatcheries.

All of the young fry from these eggs proved strong and healthy. When 1½ inches long they were sent to the rearing station at Andover, where they were placed in the small brook which furnishes water for the rearing station, instead of in the wooden pools as was done the previous year. The fish were liberated in the brook instead of the pools because the process of raising the water at the station had flooded the cellars of adjacent houses; and to avoid incurring liability for damages, or going to great expense in construction work, it was decided to try this plan. It proved a fairly satisfactory way, but there are reasons why it is not ideal, chief among them being the fact that the water cannot be controlled, and after a severe storm the young fish are subject to strong currents. Likewise it is impossible to clean the bottom of the surplus food that collects there, but the rains must be depended on to swell the stream and carry it out.

The fish were fed twice a day on finely ground liver and allowed to go up and down the brook at will. A screen placed at the dam below the rearing station prevented their escape.

Feeding of the fish was stopped about September 1, and they were allowed to go down stream when directed by natural instinct. At that time most of the young salmon were from 3 to 4 inches long, and should have been well able to care for themselves when starting on their journey to the ocean. During the season 192,000 fry and 196,000 fingerling salmon were shipped to the Andover Rearing Station from Palmer.

It is needless to say that this experiment which your Commissioners are conducting in trying to establish these Pacific salmon in New England is being carefully watched by fish culturists in all sections of the country. As stated before, it is known that shad and striped bass were taken from New England to stock the rivers of the Pacific coast, and that many other species of fish have been transplanted into foreign waters. Your Commissioners see no reason why this experiment will not be successful, and are determined to give it a thorough trial. If it succeeds it will mean a great deal to New England; but, on the other hand, if it fails it will not have cost much, and your Board will at least deserve credit for having tried to increase the food supply.

### *Chinook Salmon in Massachusetts Lakes.*

With a view to ascertaining which of the State waters are suited for the Chinook salmon, certain ponds have been liberally stocked for three successive years. A few fish have been caught in the following lakes: Big Alum Pond in Sturbridge, Onota Lake in Pittsfield, Cliff Pond in Brewster, Quinsigamond in Worcester, and Long Pond in Plymouth.

A very authentic record is on file of the fish taken in Plymouth as to weight, size and the contents of their stomachs. The foregoing cannot fail to interest all anglers and fish culturists.

### *Long Pond, Plymouth.*

One thousand fingerling Chinook salmon were liberated in this pond Oct. 28, 1915, at a season when the bass (which are quite plentiful here) had stopped feeding. This pond covers

240 acres and has a maximum depth of 93 feet. It has sandy, gravelly shores with very little grass or weeds along them. The pond is well stocked with landlocked smelts, which have a splendid spawning ground in the swift-running streams that enter this pond from Upper Long Pond, a few hundred feet above. There is no outlet to Long Pond. These smelts furnish food for the Chinooks, and from information received from persons who live near the pond they spawn in large numbers each spring soon after the ice goes out.

On May 23 Mr. James Clark of Plymouth caught a salmon in Long Pond and brought it to the office of the Fish and Game Commission. It weighed $5\frac{1}{2}$ pounds, and was identified as a Chinook salmon. This fish was not more than twenty months old from the time it was planted as a fingerling.

There are records of sixty fish caught during the season ranging in weight from $2\frac{1}{2}$ to 7 pounds. The largest were caught by the following persons: Wm. Collingwood, $6\frac{1}{2}$ pounds; George Squires, $6\frac{1}{8}$ pounds; James Clark, $5\frac{1}{2}$ pounds; J. W. Davidson, $5\frac{1}{2}$ pounds; and Edward Bassett, 7 pounds. Eight salmon were taken July 27. Almost all of these fish were taken by trolling, either on the surface or deep, some with live and some with artificial bait.

There are practically no pickerel in this pond, but large numbers of white perch and small-mouthed bass. On certain days the fishermen have seen numbers of the salmon in schools feeding on smelts which were near the surface, where the salmon could be readily observed.

A careful record is being kept of the fish that are caught as to size, condition of stomachs and the fish in general, with the idea of learning everything possible as to their habits when confined entirely to fresh water. Several anglers testify as to the fighting qualities of these fish, and could see little difference from the Atlantic salmon. Every specimen caught has been in splendid condition.

Permits to take salmon in Long Pond, Plymouth, for scientific purposes, were granted to the following persons: Homer W. Hervey, Esq., New Bedford, Mass.; Dr. W. H. Thayer, New Bedford, Mass.; and Ernest L. Bassett, Esq., Bournedale, Mass. Extracts from their reports follow.

*Extract from Report of Homer W. Hervey.*

The following table gives, in reference to each fish, the day when caught, weight in pounds, length from tip of snout to tip of tail in inches, and the greatest girth in inches.

| Number. | Date. | Weight. | Length. | Girth. |
|---|---|---|---|---|
| 1, | October 14, | 2½ | 20 | 9½ |
| 2, | October 14, | 5½ | 25 | 13 |
| 3, | October 14, | 4⅛ | 23¼ | 11¼ |
| 4, | October 27, | 3 | 19 | 10½ |
| 5, | October 27, | 4 | 23 | 11½ |
| 6, | October 27, | 4½ | 24 | 12 |
| 7, | October 27, | 5 | 24 | 12⅜ |
| 8, | October 27, | 7½ | 27⅞ | 15¼ |
| 9, | October 27, | 5½ | 25 | 13 |
| 10, | October 28, | 2½ | 20 | 9½ |
| 11, | October 28, | 7¾ | 28 | 15¼ |
| 12, | November 3, | 5⅛ | 23½ | 13 |
| 13, | November 11, | 5 | 24 | 12½ |

These fish were all of the genus *Oncorhynchus* or Pacific salmon. They were all of the Chinook species except No. 7. No. 7 was quite different from all the other fish in appearance. It had shining golden sides with intense black x-shaped spots, and its eyes seemed smaller than in the others. I counted fourteen rays in the anal fin and ten in the dorsal fin. The pyloric cæca were about sixty-five to seventy, and the branchiostegals were fourteen. This does not agree with the description given by Jordan and Evermann of the Chinook salmon, but does agree with that of the "Silver" salmon, which I consider this fish to be.

*Coloration.* — All the fish had black or very dark green backs, and their sides varied in color from a light brassy bronze to a dark copper when taken from the water. After being left over night, however, all turned to a bright silvery hue, closely resembling the Sebago salmon I caught last spring. All the fish were well spotted with black spots.

*Contents of the Stomach.* — The stomach of No. 5 was empty. No. 2 contained the remains of three minnows, species of which could not be determined. No. 8 contained two half-digested smelt. No. 10 contained five small smelt. No. 12 contained two small smelt. The stomach of No. 9 contained a ball about 1 inch in diameter of green oak leaves and nothing else. The stomachs of Nos. 1, 2, 4, 6, 7, 8, 12 and 13 were full of shrimp.

*Jaws.* — Jaws in fish Nos. 1, 3, 4, 5, 7, 8, 10 and 13 were not hooked, but both jaws of Nos. 2, 6, 9 and 12 were slightly hooked, leaving an opening on the side of the mouth when the jaws were brought together of about one-fourth of an inch.

*Organs of Reproduction.* — These organs were wholly wanting in No. 1 and No. 10. They were slightly developed in Nos. 4, 5 and 6. They were well developed in Nos. 2, 3, 7, 8, 9, 12 and 13, the organs being white in color and between 4 and 5 inches long and 1 inch in diameter and having the consistency of liver. I examined these carefully with the aid of a magnifying glass, and also made sections, but could discover no signs of either milt or roe. In Nos. 2, 6, 9 and 12 I found a well-developed duct or *vas deferens* from each organ, and classify these four fish as males. The rest of the fish were females, I think.

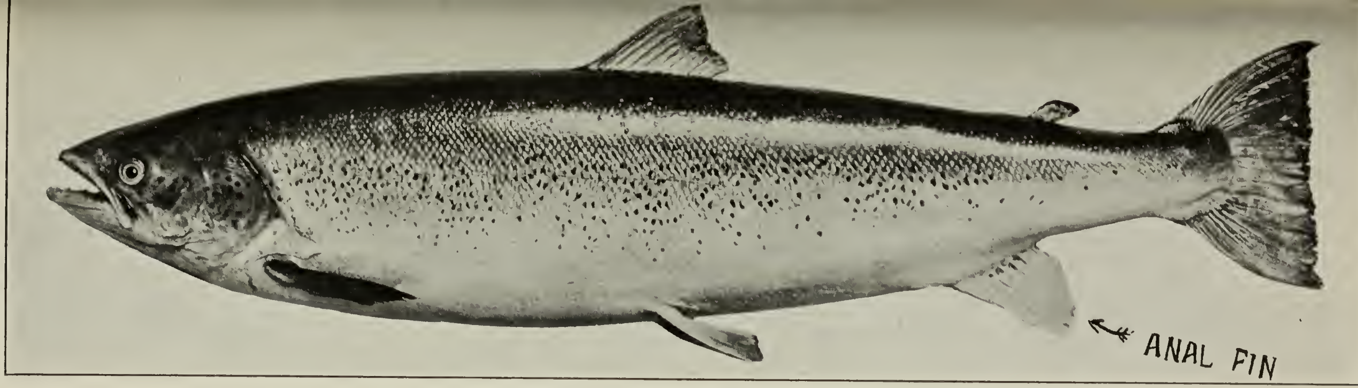
*Gameness.* — All the fish taken showed game qualities of a high degree. All made high leaps out of the water, and several made complete somersaults in the air. Under water they showed two or three maneuvers new to me. On the average all required four minutes for each pound in weight to land, using a 10-ounce fly rod.

*Conclusions.* — Taking into consideration the dates when caught and the conditions observed and the weight of the different fish, I think it is safe to say that the salmon will not spawn in this pond until the early spring, if at all. This means that the open season for this pond can safely be extended until November 1 to give the public the opportunity to fish during September and October, the two best months of the year for lake fishing.

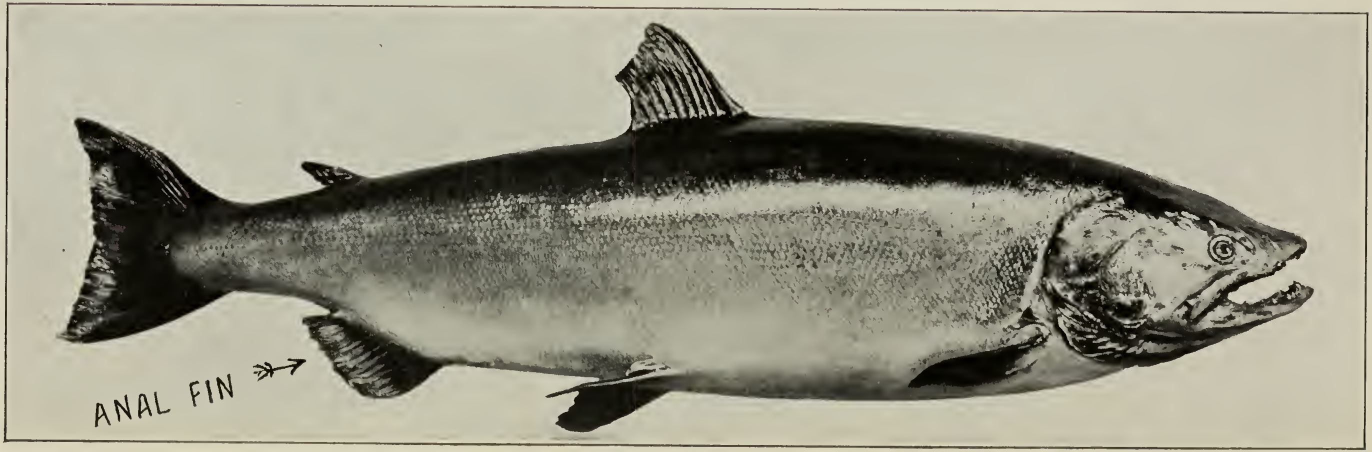
*Extract from a Letter of Homer W. Hervey.*

I started out to fish by trolling in the approved fashion. I spent several days at it by an effort of will, as I have very little use for trolling as a sport. I tried smelt, preserved minnows, and a number of artificial baits, but had no success, although the pond was fairly alive with salmon, breaking, not in play but for food. I then determined to try out a theory that had gradually developed in my mind during the summer. I had examined the pond quite carefully, and having selected a place which seemed to fit in with my ideas I anchored my boat and went fishing with live shrimp. I used a regular fly outfit, but substituted in place of the fly, No. 6 hook baited with a single shrimp. This I cast as far as I could from the boat, and let the hook sink very gradually a few feet under the surface. Fishing this way I was very successful and have taken 13 salmon ranging from $2\frac{1}{2}$ to $7\frac{3}{4}$ pounds in weight. It requires some little knack to get out the line without losing the shrimp, and this method of fishing is not so far inferior to fly fishing itself.

On October 27, in two hours (from 12 o'clock to 2 P.M.) I caught 6 salmon. I realized that this was the day of days, and not likely to ever happen again, but with my sixth fish I woke up to the fact that I had caught more than either sport or science required, and so took down my




Atlantic salmon — nine rays on anal fin.




Pacific chinook salmon — sixteen rays on anal fin.

rod and went back to camp. I then made a rule that on each week-end trip I would limit myself to two salmon. I may add I had no temptation to break that rule since, and have hardly been able to live up to one-half my contract.

I do not think I have caught enough Chinook salmon to say whether they are more gamey than the Sebago, but they certainly gave me great sport and showed two or three maneuvers that were new to me. They had a way of coming just to the surface of the water and then spinning around in a circle as though on an axis apparently shaking their heads and whole body at the same time, sending a peculiar sensation along the rod into the hand, which is decidedly unique in my experience. Several of them came out of the water abreast of the boat, where I had a good opportunity to measure the height of their leap against the side of a bank, and I think I am safe in saying that in several instances I saw at least 2 and possibly $2\frac{1}{2}$ feet between the fish and the surface of the water. In three separate cases the fish made a complete somersault in the air. The largest fish, weighing $7\frac{3}{4}$ pounds, took me exactly thirty minutes to land, and I estimate that it required about four minutes for each pound in weight to land each fish.

To live up to my permit I thought it necessary to leave well enough alone, and so I did not use a fly. The fish seemed very hungry, and rose freely to floating leaves and other small objects on the water.

In two instances they took the shrimp as it struck the water. I think they will take a suitable fly well, and next year anticipate great sport fishing that way.

*Extract from Report of Dr. W. H. Thayer.*

In October I caught one female salmon (Chinook) weighing $5\frac{1}{2}$ pounds; caught this fish trolling with a preserved smelt laced on a single hook; fish caught about 100 feet from shore in about 20 feet of water. At this time (about noon) there was no wind blowing, water was perfectly calm and there were many fish swirling on the surface. . . . I have seen and caught many salmon in Maine and Canada, and I believe that I have seen salmon in this pond weighing over 10 pounds, though none this large have been taken. . . . The surface fish seem to me to be playing, not feeding. I have seen no small fish (salmon) this year. In May I saw two weighing about 3 pounds each; since then none weighing less than 5 pounds. The fish strike hard at the troll and fight as hard as any Sebago salmon I have ever landed. . . . To sum up, I believe the salmon are not for the present going to spawn, though I do think it a future possibility; that they are more easily taken than the Sebago salmon through being less erratic feeders; that they are a game fish in these waters, perhaps superior to all others; that they grow very fast; that they are found mostly over gravel bottom; that there is a slight current in the pond from some underground or water source, and the fish to some degree follow this current; that their flesh, while inferior to the Sebago salmon, is very fine; and that the fish, under wise legislation, are a success.

*Extract from Report of E. L. Bassett.*

I have caught 7 salmon, 3 weighing 7 pounds, 1 weighing 6 pounds, 1 weighing 5 pounds and 11 ounces (the one I sent you), one weighing $4\frac{1}{2}$ pounds, and 1 weighing 3 pounds. The 7-pound salmon measures 26 inches in length and 18 inches girth in widest part. . . . During October salmon were near the surface morning and night, jumping for flies and playing, and they could be seen in any part of the pond, but after November 1 they stopped coming to the surface and did not take the bait very readily. . . . The salmon I caught were near the top of the water, and one 7-pound salmon was extremely gamey, took about thirty minutes to tire him out, and then I rowed ashore and pulled him up on the same. They were fine eating.

## White Perch.

The white perch is both a game and an excellent pan fish, and for all classes of fishermen is perhaps the most satisfactory pond fish. Your Commissioners feel that in stocking the ponds with this species they are contributing a large share toward increasing the value of the inland waters in the production of food fish. The white perch multiplies fairly rapidly, is readily taken with hook and line, and, all in all, is a most satisfactory article of diet. If satisfactory methods can be evolved for rearing this fish from the egg it will be of inestimable benefit.

### *Life History.*

*Description.* — The white perch (*Morone americana*) is found in both fresh and salt water, and is frequently taken in large numbers in tidal creeks. It has a moderately bluish body, convex back and medium-sized mouth; head about one-third the total length, exclusive of the tail; upper parts grayish green in color, and the sides silvery. The young have pale longitudinal streaks. The average size of the adult white perch is about 9 inches, and its weight one-half pound or less, although numerous specimens measuring 14 inches and weighing 2 pounds are taken. In seining operations in Falmouth it is not unusual to obtain from the brackish water ponds several hundred perch weighing between 2 and 3 pounds. The largest specimen in 1916 weighed 5 pounds and 4 ounces.

*Habitat.* — The white perch is a lover of brackish water, and may be found in tidal creeks in vast numbers associated with

mummichaugs, silversides and eels. It is now being regularly introduced into ponds and streams throughout this State. This species is found from Nova Scotia to South Carolina, and is most frequently met with in brackish water, up which it passes with the alewives to spawn.

*Food.* — It feeds chiefly on small fishes and crustacea, congregates in large schools, and is one of the freest biters among fishes. Shrimp is one of the most attractive baits, though worms, sturgeon eggs, minnows and strips of silvery skin cut from other fish are at times equally effective.

*Spawning.* — The fish spawn in the early spring, passing for this purpose from the salt water to the brackish or fresh. The eggs are very adhesive, and on this account are difficult to hatch artificially. With water at 58° or 60° F. the eggs hatch out in six days. Work in the artificial hatching of the eggs has so far not progressed beyond the experimental stage, and no definite, practicable method has as yet been devised.

### *White Perch Salvage.*

Adult white perch have been the subject of fish salvage for the past ten years in Massachusetts. At first they were taken from the brackish water ponds on Marthas Vineyard, and later, owing to the difficulties of transportation, from similar ponds at Falmouth. Most recently seining has been carried on at the Water Works Pond at Newport, in company with the Rhode Island Commission on Inland Fisheries. The increase in the number of white perch so obtained can be seen by a comparison of past years. In 1913, the last year in which the perch were taken from Tashmoo Lake on Marthas Vineyard, 15,500, the most ever secured up to that time, were shipped. In 1915, 105,000 were distributed among the inland ponds; in 1916 only 60,000; and in 1917, 77,100 (19,600 from Falmouth and 57,500 from Newport). The fish are taken in two seasons, — in the spring for a period of about ten weeks, from April 1 to June 20, and in the fall from October 1 to December 1.

The Falmouth ponds having been drawn upon during the past four years, it is now the part of wisdom to allow these nursery ponds to rest for a period of three years, which would necessitate returning to the Vineyard ponds for further stock.

To avoid any danger of seriously depleting these ponds, we are considering the possibility of forming nursery ponds in various parts of the State. This might be accomplished by stocking certain suitable ponds with approximately 10,000 white perch each year, allowing the fish to propagate extensively under careful protection. Thence perch for transplanting to ponds in surrounding districts could be easily obtained, materially decreasing the cost of transportation. For this purpose comparatively shallow ponds with good bottom for seining are recommended.

*Falmouth.* — Fish are taken in the town of Falmouth from Oyster and Salt Ponds, two large shallow, natural nursery basins of brackish water which are separated from Vineyard Sound by a sandy beach and connected during the spring by narrow inlets, up which the alewives and the white perch run. During the greater part of the year these openings are closed.

*Marthas Vineyard.* — On Marthas Vineyard fish have been taken mainly from Tashmoo Lake, but there are several sources of supply which have proved equally satisfactory. The great difficulty with regard to the Vineyard ponds lies in the fact that all shipments must be made before 5 o'clock in the morning in order to make proper railroad connections.

*Newport.* — The Newport Water Works Reservoir, which in 1917 was jointly utilized by the Massachusetts and Rhode Island Fish and Game Commissions, covers an area of about 90 acres. Originally it was a small natural body of water about 2 acres in area, known as Gardner's Pond, surrounded by marshland, but connected with the ocean by a small runway through Third Beach. It was artificially raised to its present level to form the present Water Works Pond. Conditions are now such that no fish can run up from the salt water, but the original supply of perch had so increased that large numbers can be obtained for stocking purposes. The perch were from 4 to 5 inches long, and considerably smaller than the Falmouth fish, which averaged 3 to the pound. Massachusetts furnished the gear and the services of two deputies experienced in the work to direct operations, and the Rhode Island Commission two additional men. Rhode Island received one-third of the fish, Massachusetts two-thirds.

Making the haul.

Bunting in.

Bunt staked.

Sorting fish for shipment.

*Equipment.* — The equipment for the white perch work of the past year consisted of an auto trailer 7 feet long and 3½ feet wide, capable of carrying 24 large cans, gear and a 14-foot skiff. The netting gear consisted of three sweep seines, 110, 80 and 65 fathoms in length, respectively, and six holding-pockets measuring 8 by 4½ by 3 feet, with a central partition. The pockets when staked out in the ponds were capable of holding 12 cans of fish.

*Method of Work.* — The operations, which consisted of (1) seining, (2) pocketing, (3) counting, canning and shipping, required the services of four men. In addition, it was found necessary, to insure proper delivery, to have a messenger travel with the shipment of fish.

1. The seine was operated after the usual manner, by placing it so that one end was attached to the shore and the other in the stern of the skiff, which was rowed in a semicircle from the shore. The seine was then hauled in equally from both ends, and on its approach to the shore was gathered so that the enclosed fish could not escape over at the surface, or beneath the lead line on the bottom. The nature of the bottom largely determined the amount of labor in hauling the seine. Grassy bottoms, particularly when dead grass was present, made it especially hard, and at times necessitated pitching the grass out of the seine before the operation could be completed. Successful seining in a depth of over 10 feet has proved to be impossible. The strain of hauling the seine was made somewhat easier by the adoption of a pulling harness, which consisted of barrel staves attached with rope rigging to the backs of the men, so arranged that the pull upon the same by several persons was uniform.

2. After the fish are seined they are placed in the pockets, where they are held about seventy-two hours before being shipped. This interval affords them ample chance to rest and become accustomed to confinement. Incidentally the weak fish die out, leaving only the strong for shipment.

The main difficulty in holding fish in pockets is the formation of fungus in from four to eight days, the rapidity of development depending upon the temperature of the water. Between 60° and 65° F. it forms quickly, while at 50° F. or

below, from eight to ten days are necessary. White perch are especially susceptible to fungus, particularly when handled or bruised in any way, giving the spores a chance to attack places of local injury to the skin from handling or dip nets. The most effective cure for this disease is a salt bath. In brackish water ponds, where the wild fish are taken, the amount of fungus is very slight, not over one-tenth of 1 per cent. In Newport Reservoir the average proved considerably higher, and the fish did not have the hardy, plump appearance of the bronze-colored fish from the brackish water ponds. The fish in large pockets are no less immune than those held in small, as was demonstrated by an experiment where one-fourth of an acre was screened. This fact is explained by the tendency of white perch, no matter how large the enclosure, to crowd together at one end, where they are likely to injure each other sufficiently to make them susceptible to the inroads of fungus.

3. Fish are taken from the pockets, counted and placed in the cans, 250 4-inch fish, or 70 of the 6 to 8 inch fish allowed to each can. In this way 3,000 of the 4-inch fish, or 840 of the larger fish, may be handled per day for one shipment of 12 cans. The cans are so iced that the temperature is kept from 50° to 56° F., and the water has to be well aerated constantly. A messenger takes the fish on the train in the baggage car, through the courtesy of the railroad, and they are delivered to the applicants who have been notified in advance by the deputy having charge of the white perch salvage work. In planting the fish care should be taken to see that the temperature of the water in the pond and that in the can are uniform before the fish are liberated.

### *Artificial Culture.*

Experiments made in the artificial stripping and fertilization of the white perch have so far proved unsuccessful. The great difficulty has been in obtaining ripe fish. In attempts which have been made to hold spawning perch in enclosures in Oyster Pond on Marthas Vineyard, practically all of the fish succumbed to fungus before the eggs became ripe, and it has proved practically impossible to obtain any quantity of fertilized eggs.

The experimental work in the artificial propagation of the white perch has been conducted by the department in two operations, as follows: —

1. The holding of the spawning fish in pounds until ready to spawn, and stripping them.
2. The hatching of the eggs at the Palmer Hatchery.

*Spawning Ponds.* — On April 24 a dam was constructed across one end of Deep Bottom Cove of the Great Tisbury Pond to provide a small pond for holding the white perch until ready to spawn. This dam was equipped with a flume to give a free circulation to the pond, and a boat was used for transferring fish from the nets to the spawning pond in good condition. On April 30 about 1,000 adult white perch were put into the pond for breeding purposes. On May 25 the fish were seined and 4 ripe females obtained, 2 of which spawned while held overnight, indicating that these fish do not hold their spawn long when ready to get rid of it. At this time the salt water began to back up into the enclosed pond where the fish were held. On May 30 the fish were again seined and 3 ripe fish obtained. Conditions appeared promising and the outlook most favorable for a fine lot of eggs, but the fish did not ripen, and the eggs taken at this time were transferred to the Palmer Hatchery. On June 3 no ripe fish were found, and those in the pond were not in good condition as the beach had opened, letting the salt water run out of the pond. The fish at this time showed no signs of spawning, and as all the ripe fish obtained were taken from the salt water, it perhaps indicates that white perch will not always spawn if confined for any length of time in fresh water. On June 14 all the white perch were liberated from the small spawning pond into the large pond.

The catches of the fishermen in the nets were also examined for ripe fish, but owing to the small number of fish caught in the nets none could be obtained.

In future work it will be advisable to build a fence across one end of Deep Bottom Cove to hold the fish in salt water during the entire spawning season. Such a fence can be built so that the small shiners can enter the pond for the perch to feed on, and give a free circulation of water. In this way it

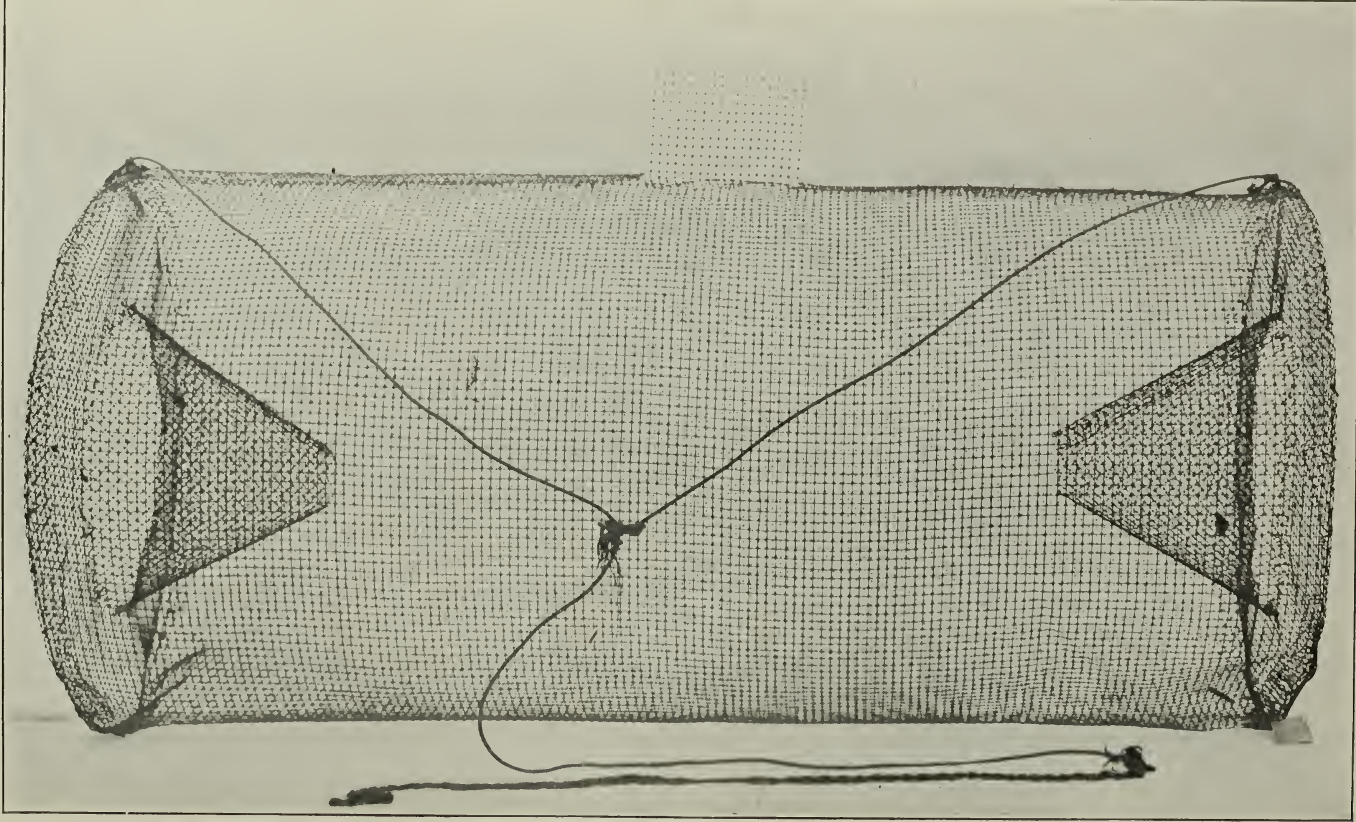
will be possible for the fish to thrive and the eggs to be obtained from the fish as they ripen.

*Hatching.* — The handling and care of the eggs is one of the hardest propositions that a fish culturist has to contend with. The eggs are adhesive, and as soon as taken they form in masses which it is almost impossible to separate, and once this has happened it is necessary to put the eggs through a screen, which often results in injury. However, by the use of a scrim (cloth) screen the eggs can be separated and properly prepared for hatching in jars. The few eggs that were obtained were hatched out in exceptionally good condition.

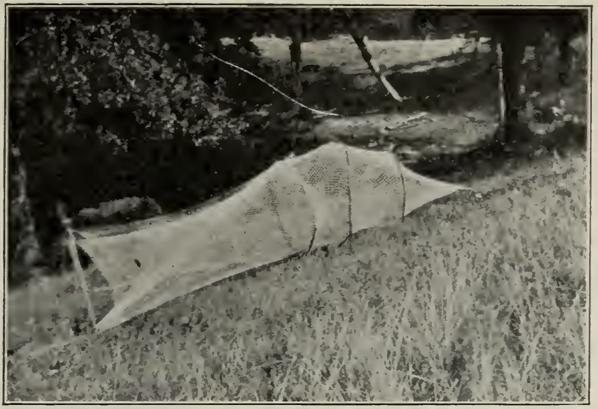
*Nursery Ponds.* — The control of certain ponds as nurseries for white perch is highly desirable. The salt-water ponds at Falmouth, especially Salt Pond, are ideal for this purpose. First, they are located near a railroad, and at the same time afford a convenient place for the workers to stay. Secondly, the water is not deep, so that the ponds can be seined without great difficulty. Thirdly, it is brackish water which better protects the fish in the pockets against fungus, and the perch get more food, breed better and appear stronger, larger and more vigorous than in fresh-water ponds. Fourthly, Salt Pond, Falmouth, gives a catch of almost wholly white perch without the numerous red perch and shiners of other ponds. By screening the stream at Salt Pond, which is about 200 feet long and 3 feet wide, a large number of breeding perch could be transplanted from near-by ponds, and unquestionably in a short time appreciable results would be shown.

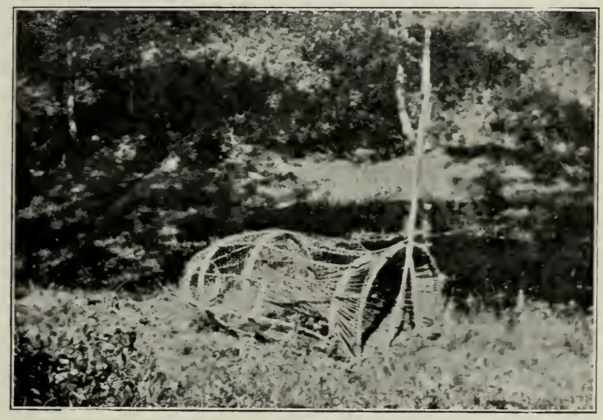
## *Stocking.*

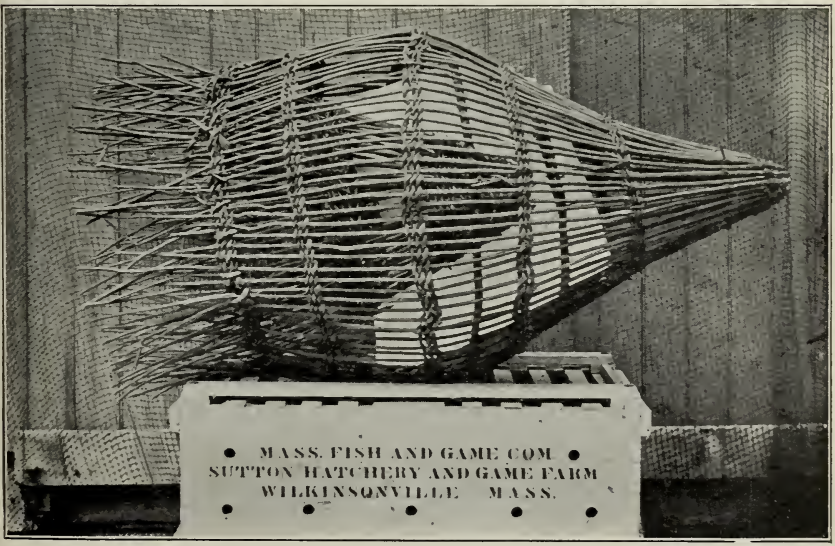
The method of stocking employed up to the present time with white perch has been that of diffuse general distribution, and results have been sought from small shipments distributed over a great many ponds. From an experimental standpoint intensive rather than extensive methods of stocking are recommended. By stocking each year about 10 ponds through the State with 10,000 white perch each, and closing them for a period of three years to all fishing, appreciable results should be obtained. Each year 10 new ponds could be added to the list, and in five years there would be excellent perch fishing in about 50 ponds.



Trap devised for use in salvage of horned pouts.








Various forms of fish traps confiscated by deputies.

*Trapping.*

The deputies who have been in charge of the white perch work will attempt during the coming year to obtain the fish in the nursery ponds by means of small fish traps rather than seines. If successful this should prove an ideal method, for the trap will work continually, and eliminate the undesirable handling of the fish in the seines. The proposed traps will have a leader of 1-inch mesh from 50 to 75 feet in length, and a "heart" of $\frac{1}{4}$-inch mesh 20 by 30 feet. Fish will be held in pockets as heretofore, and there will be no other change in the present methods of handling.

*Fyke Nets.*

Large fyke nets, like traps, may be used successfully in perch salvage. In addition to the "wings" they should have a leader which would guide fish into the body of the net.

### Horned Pout.

The horned pout is a valuable food fish, and should be protected by reasonable laws restricting the catch and the season. Its capture should not be allowed before June 20. The hours in which they may be captured in the early morning or late at night coincide remarkably with the hours of leisure of the working man, who can thus have the sport of fishing and provide food for his family without financial loss. Verily, the horned pout is a poor man's fish.

For this reason the horned pout has been taken as an example of our valuable fresh-water food fishes. This fish is readily transported owing to its hardy nature, can be taken in fairly large quantities, and readily adapts itself to its new environment.

*Salvage.*

Salvage work has been extended to the horned pout, known also as the common catfish, bull pout, bullhead, and minister. In carrying on the work of transplanting, a trap similar to a wire eel pot was devised and used with much success by one of the deputies engaged in the work. This trap is cylindrical,

4 feet long and 2 feet in diameter. At the large end of the cone the opening measures 12 inches, and at the small end, 2 inches. Each wire cone extends into the trap a distance of 12 inches, the space between the outer end of the cone and the outer edge of the trap being 6 inches. The opening at the top is for the purpose of removing the captured fish.

The quantity taken with this style of trap depends upon the time of year, how well the fish come to bait, and the number and size of the traps used. During warm weather it is necessary to tend them every two or three days, or the fish thus confined may die in the warm water. At times traps have been pulled and found to contain not a single fish, while, on the other hand, the other extreme is occasionally reached, as many as 710 having been taken in one trap at a hauling. A small piece of lean beef, so suspended as to be readily seen, proves the best bait, although a piece of fish works very well. Unless very hungry few will venture near irrespective of the kind of bait used.

The location of traps for best results depends also upon season. Inshore, in from 3 to 5 feet of water, during May and June, proved best, while later, from July to November, more fish could be taken in deeper water or in the channel. In a pond of 15 acres or over traps were placed in close proximity, while in the case of very small ponds scattering them about proved to be as effective. Leaving a few fish in a trap each time proved a lure to others. One means of securing practically all of the fish in a small pond was by the use of a netting fence stretched entirely across in a zigzag fashion, with two apices, at each of which a trap was set. In traveling in either direction the fish were bound to strike the net and thus be led into the trap.

## Smelt.

Among the fish which frequent tidal streams to spawn the smelt is valuable not only as human food, but, when land-locked in inland ponds, furnishes important food for the larger fishes. Owing to the depletion in Massachusetts waters of this very valuable fishery, your Commissioners have laid plans to protect the spawning grounds, and to discover the best means

of increasing the number of fish by natural and artificial hatching. Work has been carried on simultaneously on the salt water, the fresh-water ponds and at the Palmer Hatchery. While the work is as yet in the experimental stage, results have been so promising that it is thought best at this time to present a preliminary report.

A brief sketch of the life and habits of the smelt is given as a basis for a better understanding of the work later described.

## *Life History.*

*Names.* — The smelt (small fishes frequenting the coasts of Europe and northern America, sometimes ascending the rivers) are delicate in flesh and considered valuable as food. The common North American species is most generally known as "smelt," although at Port Henry, N. Y., it is called the "ice fish." According to Bean another fish, *Notropis hudsonius*, a fresh-water minnow known as the "spawn eater," is sometimes called a "smelt."

*Description.* — The smelt is a small slender fish, the adult averaging about 7 inches and even attaining the maximum length of 1 foot. The long pointed head with projecting lower jaw carries a tongue armed with several fang-like teeth. The back is greenish in color, and a broad silvery band passes along the sides.

*Habitat.* — Along the Atlantic coast the smelt is found from Labrador to Virginia, although essentially a cold-water species. In the spring it ascends the coastal streams to spawn, and is most frequently observed in the first stages of cold weather in the various Massachusetts harbors.

The smelt has also become landlocked in various fresh-water ponds in the New England States. Although smaller in size it thrives almost as well as in the salt water. In recent years the range of the landlocked variety has been widely extended by the artificial introduction of fertilized eggs into the inland ponds of Massachusetts.

*Spawning.* — In Boston Harbor spawning is during March and April, the exact time depending upon the temperature. In the fresh-water lakes, as Onota Lake, Pittsfield, the season, lasting seven days, varies with the time the ice leaves the lake,

since the fish start running up the brooks about ten days after the ice has gone. The fish lie around the mouth of the spawning brook two to three days before starting their run, which occurs at night, the fish returning to the lake at daybreak. During the first three nights the large ones pass up, then for a few nights the medium sized, and finally the small ones, evidently yearlings. So many fish run up Parker Brook from Onota Lake that they actually force each other out of the water on the grass and gravel sides of the stream. The spawn is deposited, one layer of eggs upon another, to a depth of about 2 inches, which inevitably results in millions of eggs being annually lost under natural conditions. When so covered the bed of the brook has the appearance of one large yellow sheet.

A similar condition is found on the natural spawning beds of the salt-water species. At Weir River, Hingham, in 1917, the smelts were depositing spawn on the river bottom at the rate of a quarter of an inch each night when there was a good run. Eggs would be found in layers from 1 to 2 inches in depth, and in eddies, even from 4 to 6 inches. Under such circumstances the top layer only is exposed to the running water and properly fertilized, the remainder being wasted. The eggs are adhesive and attach readily to stones, gravel or other suitable objects. They measure one-twentieth of an inch in diameter, and count 496,000 to the fluid quart. The eggs hatch out in the fresh water, and the young fish later return to the salt water. At Weir River high course tides, flooding the lower spawning grounds, occasionally kill quantities of eggs by the action of the salt water.

### *Value and Present Condition of Smelt Fishery.*

The smelt is highly prized as an article of diet. It is also considered of value as a bait, and has proved a most satisfactory and ideal food for the fishes of the inland lakes. The smelt fishery of Massachusetts, while never achieving a commercial importance like that of the New Brunswick fishery (an important winter fishery, carried on through the ice, and the product shipped frozen to market), is now of value to the recreational fisherman, and does represent a substantial food

supply. The commercial possibilities should be the primary reason for its development, for conditions can be made favorable to restoring the once abundant supply.

The stocking of the fresh-water ponds with them as a fish food is now of great importance. Moreover, the rapid increase in the smelt thus established in fresh water encourages us to believe that in time some of them may be taken for food.

Exact statistics of the decline of the smelt fishery in Massachusetts are probably not of much importance, but in former days quantities of smelt could be taken during the proper season. In the gradual reduction of the spawning beds the smelt as well as the other anadromous fishes became scarce on the Massachusetts coast. At the present time there are two spawning localities in Boston Harbor, — Weir River at Hingham, and the tributary streams to the Weymouth Fore and Back rivers. Here and in other localities their grounds have been restricted by dams and pollution. At Weir River there was formerly opportunity for the smelt to pass up the stream for several miles, whereas now they are limited to a stretch of about 120 feet. The pollution of other streams entering Boston Harbor has doubtless driven an excess of smelt to Weir River, which is comparatively free from foreign material. The oversupply of smelt for these limited areas explains why the eggs are deposited in such thick layers that the greater part perish.

This year, to ascertain the magnitude of the smelt fishery and just what value it has as an asset of the Commonwealth, an investigation was conducted which resulted in some surprising revelations. On one Sunday morning along the coast at and adjacent to Hough's Neck no less than 2,326 persons fishing for smelt were actually counted, leaving out of consideration the number who were out during the very early morning. In notebooks which were placed at every pier and yacht club for the purpose of registration as a part of the general census, 144 persons reported their catch to be 1,095 dozens. Computed roughly, this averages more than 90 fish apiece, or 6½ pounds figured at the rate of 14 fish to the pound. Continuing on this same basis the 2,326 persons observed in the act of fishing on this morning might easily have taken about

15,119 pounds, or 7½ tons, of smelt, with an approximate value of no less than $3,023.80. But even this is not the full money value, for in addition to actual market value these fish surely must be considered as of some worth from the viewpoint of providing recreation. As a very conservative estimate let it be considered that the sporting value to the fishermen of catching these fish averaged 10 cents per hour, and each person stayed out for three hours. This gives a total of 6,978 hours with a value of $697.80 to be added to the actual market value of the fish of $3,023.80. Such presentation of facts would seem to be about the best possible argument which may be advanced in favor of the Commission's comparatively new-born activity of artificial propagation of smelt with which to rehabilitate such coastal streams as still remain suitable.

*The Problem of Restoration.*

In general a fishway is not a practical contrivance for smelt. At Weir River smelt were observed to shoot some very sharp falls. If the fish could get over the first dam they could reach extensive spawning grounds. However, the return over the dam would probably injure these delicate fish, and therefore it would be necessary to screen the spillway.

The real problem confronting the Fish and Game Commission is that of providing a spawning ground equal, as far as possible, to that which the smelt enjoyed before the day of dams and pollution, and to institute methods of saving a large per cent. of the spawn wasted at present in such places as Weir River. To remove the pollution from the streams entering Boston Harbor will require considerable time, and probably never will be accomplished if present conditions are any criterion. The enlargement of the spawning grounds by removal of dams or installation of suitable fishways is likewise a work of years. The immediate relief of the smelt problem which will save this species from commercial extinction in Boston Harbor consists in saving the natural waste of surplus smelt eggs by artificially enlarging the spawning grounds to accommodate the number of smelt which frequent them.

*Methods of Restoration.*

The general plan of work was laid out in four divisions: —

1. At Weir River, Hingham, as regards methods of saving the great quantities of natural spawn annually wasted, and of catching and holding a part of the adult fishes.

2. Ascertaining the most effective methods of handling and shipping the eggs and adults for the stocking of fresh-water ponds and tidal streams.

3. Observations on the spawning habits of the landlocked smelt, and the collection of eggs at Onota Lake, Pittsfield.

4. Artificial stripping and fertilization of the eggs, and the hatching of them in batteries at the Palmer Hatchery.

The year's work aimed to realize four definite objectives. A detailed account of results in each is given.

1. *Protection of the adult smelt, especially on the spawning grounds during the breeding season, by the rigid enforcement of effective laws.*

Since 1911 the control of the smelt fisheries of Weymouth and Braintree has been vested in the towns (chapter 306, Acts of 1911), but nothing has ever been done by the local authorities, and the spawning grounds have never received adequate protection, despite the fact that the Commission has each year given a greater or lesser amount of attention to these brooks, depending on the number of men who could be spared from other work. This year the Commissioners determined to assume the responsibility of bettering conditions, seeing the towns would not act. When the fish began to run in the spring a sufficient force of deputies was detailed to patrol the Weir and Weymouth rivers, day and night, during the spawning season, and the illegal taking of fish was stopped. When the citizens were informed of the purposes of the Commission as to patrol and propagation they immediately gave it their hearty support.

2. *Restocking depleted coastal streams by transplanting spawning adults and fertilized eggs.*

The transplanting of the adult smelt from Weir River was attempted, but the brood fish proved too delicate to warrant it as a routine practice. The smelt were placed in small cars in the stream until the time of shipment. If injured by

handling, even in the slightest degree, the injured part would become covered with fungus, and the fish would soon die. Likewise fish injured in transit or during the canning process would either die *en route*, or shortly after reaching the destination. However, successful shipments were made by train to Byfield, Rockport, Kingston, and by automobile to Brockton, in the regular shipping cans.

Observations having shown that great numbers of eggs deposited under normal conditions were lost either through smothering or accident, the following effort was made to improve on the natural process. Pieces of coarse burlap, tacked on wooden frames and anchored on the bottom of the stream, made an artificial bed over which the spawning fish had to pass. Large numbers of eggs were deposited on these improvised beds, which were left in water long enough to harden, and then rolled up, packed in baskets of wet moss, and shipped. The receivers staked them out in quick water in the brooks to hatch; 62,750,000 eggs were thus distributed.

3. *Stocking inland ponds with smelt to furnish food for the predaceous fish. In this work both eggs and adults from the salt water and from certain fresh-water ponds, where the landlocked smelt have become numerous, are utilized.*

The method of handling the adult smelt work at Onota Lake is as follows. The fish, netted as they ran up stream, were kept in a box 6 by $2\frac{1}{2}$ by $1\frac{1}{2}$ feet in size, to which they were carried in pails from the point of netting, a distance of 400 yards. From this box the cans for transportation were filled. During the past four years about 60,000 adult smelt have been transplanted from Onota Lake to other ponds.

If the eggs are allowed to remain in the tributary brooks of Onota Lake, millions are lost owing to the depth of the layers. When the eggs have attained the eyed stage they are ready to be transplanted. They are gathered by slipping the hand under the bottom layer, both good and bad eggs being placed in a basket lined with burlap which first had been soaked to hold moisture. The eggs are then ready for transportation and can be shipped for comparatively long distances. This year approximately 36,000,000 eyed eggs were shipped from Onota Lake. After the eggs have been placed in the

baskets a strong odor is noticeable which would give one unfamiliar with this work the impression that the eggs had spoiled, but this is not the case, since if examined microscopically the eggs are found in good condition.

4. *Perfecting methods of artificial stripping, fertilization and hatching.*

Smelt can be stripped in the same manner as trout, but the fish do not survive the process, as they are sensitive to handling. The eggs are readily fertilized, but owing to their adhesive nature (they adhere to everything except glass) it was found necessary to strip only a few fish of each sex at a time, and to continually stir the mixture in water for an hour or more, and afterwards at frequent intervals, until it was placed in hatching jars in which the churn of the battery accomplished the same result.

About eighteen days are required to hatch smelt by this process, but by the use of warmer water this may perhaps be reduced to fourteen days. With a hatchery at Weir River three lots of eggs could be hatched during the season. A portable building could be located on the bank of the stream, and water from the pond above could be piped with sufficient pressure to serve for hatching. Electricity and other conveniences, such as city water, could be obtained near by. In regard to space and equipment it is estimated that 400 smelt can be hatched per jar, and that by placing the jars four high a 50-foot row would accommodate 400 jars and yield 160,000 fish.

Another method, which was less successful, was to take the eyed eggs from the fresh-water streams and hatch them in a trout-hatching trough with running water.

## Fish Salvage.

This subject has been discussed to some extent in connection with the account of work on the white perch. Fish salvage is the prevention of natural waste, such as the rescue of stranded fish from streams in times of overflow or drought, and transfer from overstocked ponds to more suitable waters in which the natural supply of fish is low. It will play an important part in the future activities of the Commission. Plans are now

under way for extending the work of fish salvage to private waters, reservoirs and ponds where public fishing is prohibited, in order to place the fish in waters open to the public.

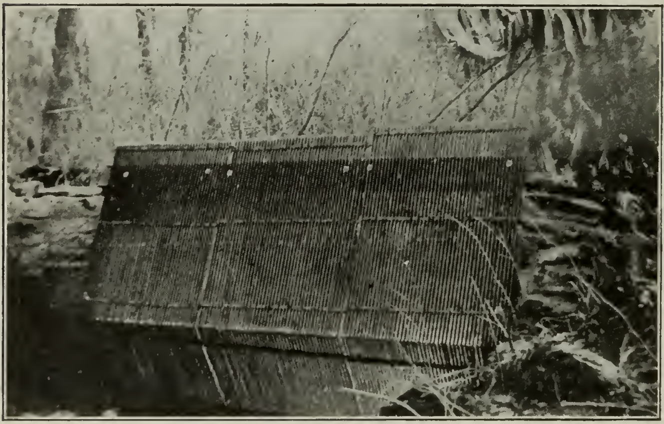
By this means thousands of adult fish may be annually provided for public waters in addition to the output of the hatcheries. Although once a mere side issue, fish salvage has become of equal importance to the other branches of fish cultural work. During the past ten years with the white perch, and more recently with the horned pout, the Commission has worked out some efficient methods of fish salvage.

Satisfactory work can be accomplished only by trained men provided with necessary equipment. Its proper performance will require the services of two crews of five men each, who can devote to it their entire time for several months each year. One crew would be assigned to the salvage of white perch from the brackish ponds near the coast, and the other to distributing various species of fish from pond to pond, according to the needs of the different localities. Each crew should be equipped with an automobile truck carrying the requisite apparatus.

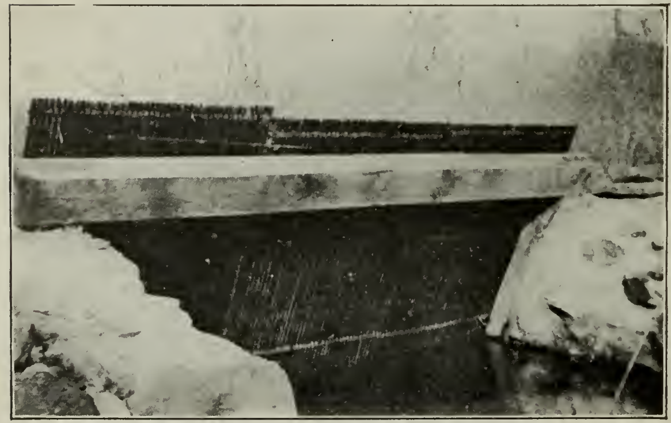
With the necessary equipment and men the possibilities for the extension of the work of fish salvage are alluring. The double crew of highly trained men with the additional equipment can accomplish efficiently twice the amount of work that is being done at the present time. Greater stress can be placed upon the work in the fresh-water ponds with species other than white perch, as the entire time of the extra crew can be devoted to such fish as bass and horned pout. It can be readily realized that millions of fish, both young and adult, can be preserved by extending work along this line.

In addition to rescuing fish from overflowed and dried-up streams, or where pollution has suddenly become too great to allow of their existence, the work of transferring fish from water supplies and other ponds in which the public are not allowed to fish is perhaps the most important part of fish salvage. Massachusetts has within its bounds approximately 175 ponds used as reservoirs, and several hundred artificial ponds in which public fishing for one reason or another is not permitted. For this reason, wherever fish can be economically and satisfactorily removed from these ponds and placed in

Outlet of Big Pond, Otis. Showing abutments and frame, ready for screen.



Screen at the outlet of Big Pond, Otis. Showing screen placed in position.



Screen at the outlet of Big Pond, Otis. Showing rear view of screen and abutments.

waters which are open to public fishing it should be done. In this way the water supplies and private ponds can be relieved of their surplus fish, to the benefit of the public waters.

## Screens.

Much money has been wasted in the past by stocking the lakes of Massachusetts with migratory species of fish such as salmon, rainbow trout and white perch without first placing screens at the outlets. It is the nature of these fish to seek the salt water when they arrive at a certain age, and if they have a free passage they will drift down the streams never to return. This has proved to be the case with many fish that have been planted in the State waters.

Several instances are known where white perch have been taken in streams *below* the lakes in which they were liberated. when none had ever been caught in the lake. The same is true of black bass. It has been impossible to get results from planting any species of salmon in lakes that have free outlets. If there were no dams the fish might come back to some extent, but if salmon fishing is to be established in our lakes it will be much better to have the outlets screened and thus keep the fish landlocked.

During the past year representatives from this department have advised persons, interested in having screens installed, as to how the work should be done, going so far as to plan the kind best suited for the particular place. Among the sites thus investigated were Lake Attitash in the town of Amesbury, where a screen is being installed by Ralph S. Bauer, Esq., at his own expense, and at the outlet of Big Pond, Otis, where one has been installed by the Westfield Camping Club, of which James F. McPhee, Esq., is president. The outlet to this lake is only 10 feet wide, and does not have a very swift current. Abutments were built of rock and cement, and a frame of 8 by 8 inch oak timbers made for the iron screen to rest on. This screen was 10 by 6 feet, built in three sections to insure easy handling. When in place it rests upon the frame, which has a slant of 45 degrees. This pitch allows the screen to be easily raked whenever it gets clogged up with débris, such as grass and leaves.

It would seem advisable for the work of installing all screens to be in the hands of the Commissioners, with a fund provided for this purpose. As it is now this work if done at all, must be undertaken by individuals.

The iron screen that was placed at Stringer Dam in Lake Quinsigamond has caused so much trouble each year, by getting clogged up with leaves and other refuse during the fall, that it was thought best to remove the same and have it installed at the lower dam near the mill at North Grafton.

## Work at the State Fish Hatcheries.

### *Palmer Hatchery.*

The working plan of all the hatcheries is to so systematize the various operations that there will be no periods of idleness. This can be effected only in those hatcheries having facilities to raise several kinds of fish. During the winter the hatch house contained salmon and trout eggs; in the spring the batteries hatched perch and smelt eggs; and during the summer the bass were bred in the open ponds.

The two new bass ponds built last season were used for the first time, and although not well covered with vegetation they were of considerable help in furnishing a place to hold the young fish.

As early as possible the pond system should be extended on both sides of the stream to give more room for rearing the fish to fingerlings, also to furnish ponds for breeding other fish, such as crappie, blue-gill, sunfish and bullheads. There is water enough not utilized to-day to supply a number of additional ponds.

The 600,000 Chinook salmon eggs were shipped from the Oregon Fish and Game Commission, and came by express packed in cases of 100,000 eggs each. It took six days to cross the continent, and they were in splendid condition when received in November, 1916. The fry from these eggs proved to be strong and healthy, and when they were ready to ship, a large portion were transferred to the rearing station at Andover for liberation in the Merrimack River.

Fifty thousand brook trout eggs were taken from wild trout

in the hatchery stream and hatched out, the fry being sent to the Sandwich Hatcheries as an addition to the brood stock.

In former years the supply of perch spawn has been received from the United States Bureau of Fisheries. This year they gave notice that it would be impossible to furnish any. On receipt of this information a supply was located in this State, which is referred to in the article on yellow perch. Sixteen million fry were distributed.

Very little was done this year in the way of improvements at the station, except to grade the grounds and build a gravel road around the hatchery buildings and ice house, mostly by the regular employees at intervals during the summer.

The superintendent and his assistant were obliged to be away for a considerable time in looking after the work at other places. The superintendent had charge of building the rearing stations at Montague and Amherst, besides investigating other propositions which occupied a considerable amount of his time.

This station is being developed as fast as funds can be secured to do it, and as experience shows that it is safe to branch out further in certain directions.

*Sutton Fish Hatchery.*

No changes of importance were made in the station during the past year except to carry on the work of clearing out useless equipment and of gradually working over the grounds, bringing them into a better physical condition. Trout eggs were hatched in both of the hatcheries with the usual degree of success.

Early in the spring experiments were started to see whether it would be practicable to ship the early hatched fry from the Sandwich Hatcheries to this station, to be reared here and distributed in the western part of the State, the idea being to apply the rearing station principle to this hatchery. A substantial number of the Sandwich fish were sent to Sutton and placed in pools opposite similar pools containing the Sutton fish. Efforts were made to have the fish from each station receive the same quality and quantity of water and the same food. By reason of being hatched earlier, the Sandwich fish made more rapid progress and appeared to take kindly to the

experience. These experiments were made with a view to further consolidation of the work in line with that described in connection with the Sandwich Hatcheries. The plan during the coming year is to do away with the hatching of fish at the Sutton station, and to distribute the stock of adult trout heretofore maintained there. Both of the hatchery buildings are poorly constructed, and one especially is very old. It is planned to turn the hatchery into a rearing station, that is to say, the old hatchery buildings will be torn down, the bird-rearing equipment will be removed, and the grounds will be cleaned up and laid out in an attractive manner.

As funds become available it is planned to build such additional rearing pools as can be constructed, in order to fully utilize for rearing purposes all the available water. Each spring a sufficient number of fry will be sent from the Sandwich Hatcheries to fill the requirements of the station, and the fish will be reared here, to be distributed in that part of the State within easy carrying distance of the station. Such a change your Commissioners believe will result in a very substantial financial saving, and at the same time make it possible to increase the annual output of fingerlings from this station.

*Adams Hatchery.*

During the past three years experiments have been made with the water available at this station to determine if it were possible to raise a large number of fingerling brook trout. A stream which flows near the hatchery building was leased, and the water brought over to the hatchery grounds and mixed with the spring water which supplied the nursery ponds, in an attempt to secure as much water as possible for the hatchery work. This plan, followed for three years, has shown such meager results that the Commissioners have discontinued this hatchery.

*Sandwich Hatcheries.*

The work at these stations throughout the year has followed very closely the lines of preceding years. Owing to the lack of funds no reconstruction work or new work has been attempted. The house held under lease at the East Sandwich

branch was altered to a slight extent and some of the rooms repapered to permit housing two of the assistants and their families, whereas heretofore but one assistant had occupied the premises. It is found that much better results are obtained from employees if they are comfortably located near the stations. From this house one can see the entire hatchery grounds, thus making it possible at all times to keep the plant under observation.

A great deal of work must be done at the East Sandwich branch within the next few years to replace the present pools which are simply earth-bottomed pools walled with heavy planks. The planks are gradually rotting out, it is very difficult to keep the pools tight, and it is remarkable to see how many small trout will wedge into the smallest hole and suffocate. The small wooden nursery pools, into which are placed a large number of the fry when first taken out of the hatchery, are in an even worse state of repair, requiring constant work to keep them reasonably tight, and some may have to be abandoned during the coming year on this account. Some progress has been made in cleaning up both stations, grading, clearing out underbrush and putting the grounds in more attractive condition.

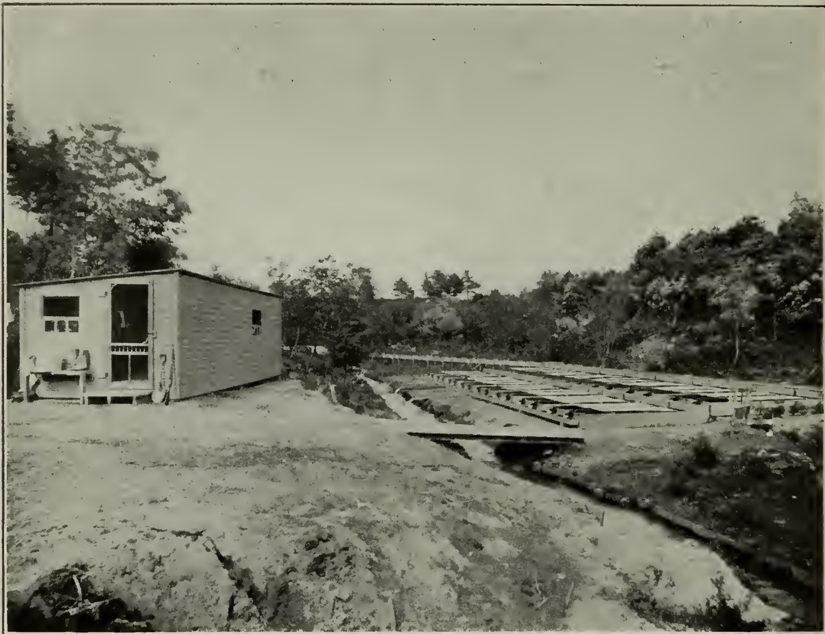
The principal attention has been given to more intensive development of the plant as it now stands. With this in mind a new type of hatching trough is under investigation, the same being, in brief, a large deep trough in which may be arranged a number of trays, one on top of the other, each containing a substantial number of eggs, and so arranged that the water may flow through all the trays, thus making it possible to hatch a large number of eggs in the present hatchery building and with the same water supply. In addition to this, other arrangements are being tried, such as a second series of hatching troughs under the present set.

Your Commissioners believe that the Sandwich plant is the one at which to hatch all of the brook trout eggs taken. Owing to the temperature of the water the eggs can be hatched much earlier than at any other station. It is with this in mind that attempts are being made to double up the hatching arrangements as above indicated, in order to develop every possible

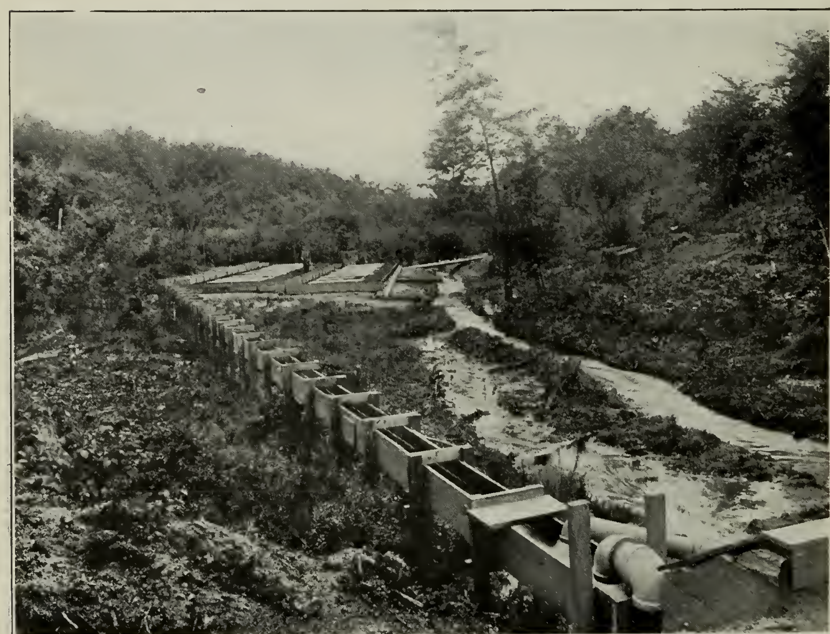
economy at the plant. If the present experiments prove a success the outlook is hopeful that during another year all of the brook trout eggs can be hatched in the present hatchery building.

This is also the logical place to keep the entire brood stock of adult trout. It is highly beneficial for the fish to have access to salt water from time to time, and this is rendered possible by the fact that the stream at the East Sandwich station (where the adult fish are kept) connects with the ocean, the tide coming up to the hatchery grounds. By liberating a limited number from time to time in this brook the fish can run to salt water. The most of them return, and it is a simple matter to recapture them. With the adult stock maintained at the East Sandwich branch, and all the brook trout eggs hatched at the Sandwich station, the program of general consolidation will be furthered. Your Commissioners hope that some time the real hatchery building of this plant can be established at the East Sandwich station. There the water can be utilized in varying degrees from the pond, which is the main water supply. It is a small but deep pond, and by taking the water from the bottom in one set of pipes, and from the top in another, the hatching of the eggs can be regulated much more successfully than at present in the hatchery building at the Sandwich station. The only hatching building to-day is a small plant at the Sandwich station where artesian water is used. This water is so warm that the fish hatch very early, comparatively speaking, and often it is a problem to know how to take care of the excess number of fry when the fish have grown to the size when thinning out is imperative. When the fry are ready to be distributed from this station the streams in the middle and western part of the State are often so frozen up that it is impossible to satisfactorily distribute the fry. It is a pleasure to be able to say that with the establishment of the rearing stations described in another part of this report it is hoped during the coming year to care for all the stock of fry without being obliged to make premature distributions.

The object in view is to consolidate at the Sandwich Hatcheries all the hatching and the first steps in the rearing of the annual supply of brook trout. From there the fish will be sent when



Montague Rearing Station in operation.



Montague Rearing Station. Intake pipe and raceway below the dam.

small to the rearing stations established in various parts of the State. It will be necessary to operate the rearing stations only during a portion of the year, thus doing away with the upkeep and expenses of large hatchery plants.

The work of hatching landlocked salmon was continued with a substantial output from 100,000 eggs received from the Maine commission. These fish, however, grow very slowly, and it is a question whether they should be distributed before they are at least a year old. The Commissioners have great faith in holding the fish until they attain a substantial size and are thus better able to care for themselves.

The firm from which rainbow trout eggs had been ordered was unable to supply them, with the result that late in the spring 75,000 fry were purchased from the Plymouth Rock Trout Company. These were distributed in nearly equal numbers to the Sandwich, Sutton and Palmer hatcheries. The fish made a fair growth at Sandwich and a substantial number were liberated.

## Rearing Stations.

Your Commissioners are convinced that the best results will be obtained if it is possible to plant the output of brook trout as fingerlings rather than as fry.

In the past it has been necessary to send out the largest part of the trout soon after the egg-sac was absorbed, and it has been possible to hold to the fingerling stage only a small part of the fish hatched.

In order to supplement the rearing facilities at the stations and reduce the cost of distribution by raising the fish in the locality where they will be planted, your Commissioners have inaugurated a system of rearing stations.

Such stations have been built at Montague and Amherst. By establishing more such rearing stations the hatchery output of fish for the inland waters will be greatly increased. It is planned to extend this work during the coming year, and if funds are provided other stations will be established in different parts of the Commonwealth to handle the increased production of the State hatcheries. In this work every sportsman should have a vital interest.

The value of the rearing stations in fish culture consists in (1) relieving congestion at the hatchery as the fish increase in size, thereby permitting a greater output; (2) lowered cost of transportation, since the fish are reared near the places of distribution; (3) less damage to fish from long-distance transportation; and (4) greater production at less cost.

The establishment of a rearing station is a more important problem than is commonly supposed or appears at first sight. A number of conditions have to be considered, since upon proper selection and development depends its future productive capacity. The proposed site of a rearing station should be first carefully inspected by an expert. Detailed plans should be drawn and estimates made as to the exact cost of the work before any steps are taken.

The location of a station has an intimate bearing upon the ultimate success of the project. The distance from a railroad station, as well as the character of the roads, are both important factors, as these govern the cost of transportation of fish and supplies. Good roads are a necessity, and this expense should be included in a consideration of the cost of production. In addition there should be a suitable and convenient place for loading and unloading fish at the station.

The water supply is perhaps the most important consideration of all, for an unfailing supply of known capacity must be found. The minimum amount of water to be depended upon must be known, and for this reason sand springs are to be preferred to side hill or rock springs, which are more dependent upon rainfall. Surface water, which brings down silt into the hatching troughs, is to be avoided. The amount of water to be used naturally depends on the number of fish and the number of hatching troughs or pools to be used. Before a location is taken the amount of water should be approximated either by a meter or by building a small weir and measuring the width, depth and rate of flow.

It should be continually borne in mind, when establishing such a station, that it is not to be a temporary contrivance, but is to be built for permanent use, and after a preliminary trial has shown the possibilities to be promising, all work should be made of permanent construction, which should in-

clude dams, rearing pools and satisfactory buildings for tools, storage, workshop, and living quarters for help.

As a rule, rearing stations are one-man stations except when fish are being distributed.

As an illustration of what has been accomplished during the past year with the first series of rearing stations, the work at the Montague and Amherst stations is described in detail.

### *Montague Rearing Station.*

The Commissioners leased 80 acres of land in the town of Montague from John Bitzer and Joseph Fournier for a period of three years with an option of purchase. If the rearing station proves of value it can be continued as a permanent possession of the Commonwealth; and, if found to be unsatisfactory, it can be abandoned without appreciable loss, — a policy which has been consistently followed in the establishment of all hatcheries, game farms and other enterprises. After a most careful examination by experts as regards water flow and possibilities of rearing trout, a rearing station was erected during the spring and operated from June 13 to October 15.

The station is located on the highway running between Montague and Greenfield, 1½ miles from the Boston & Maine Railroad station. From this location it should be possible to supply the northern, western and central parts of Massachusetts with fish at less than it formerly cost.

The water supply is derived entirely from sand springs, and the flow scarcely varies during the year. The temperature of these springs ranges between 45° and 50° F., and remains practically constant the year round. During the summer the water in the pools ranges about 53° F., rising to about 58° F. in the afternoon. At all times there was more than sufficient water, and it was estimated that 350 gallons per minute flowed through the rearing pools.

About 1,500 feet below the first springs a dam 6 feet high, consisting of earth with a core of matched planking 2 by 6 inches, was constructed to control the water supply and regulate the temperature. It was thought advisable not to make a permanent construction, as the location had not been thoroughly

tried out. From this reservoir water was taken by means of two galvanized iron pipes which passed under the dam into a wooden raceway. One took water from the bottom, the other from the top or at any point necessary to give the desired temperature, the water at the bottom averaging during the month of July about 6 degrees colder than the water at the surface.

The raceway conducted the water to a trough that supplied 32 nursery pools 16 feet by 3 feet by 18 inches, set in tandem fashion at right angles to the feed trough. Pipes 1½ inches in diameter took the water into each tier of pools. The main stream from the spillway in the dam was straightened and deepened for about 300 feet below to a point where it joined the other stream just below the nursery pools.

A building 10 by 20 feet was erected, containing two rooms, one for the preparation of fish food, the other for a sleeping room for the superintendent. The requirements for the future development of the station comprise an ice house and a fence around the entire property to keep out cattle. The number of rearing pools can be increased to the maximum capacity of the water.

A road was constructed to facilitate the delivery of fish and supplies, by means of which transportation in the future will be greatly improved. Further work will be in the nature of making another road from the main one, thus saving a quarter of a mile, or putting the present road, which is not safe for auto trucking, into better condition. For a one-man station an auto truck will be necessary, since during the past summer it has taken practically all one man's time to look after the trucking by team.

The past year, although the first and therefore the hardest in many respects, has proved satisfactory. The fish made rapid growth and were distributed in fine condition. By reason of the location in the center of the territory where fish are annually planted, it was possible to lighten the strain of transportation, which is always a benefit to the fish. The first fish, a lot of 10,000 shipped from the Sandwich Hatcheries, were placed in the pools on June 3. From that time until June 26 shipments came every day, and by July 2, 84,500 fish had been

received at the station. These fingerlings were fed twice daily with carefully prepared liver. The screens of the pools were cleaned three times daily and every ten days the pools were cleaned out and fresh sand put in. On August 9 distribution was started, and by September 8, 46,000 No. 3 and No. 4 fingerlings had been shipped from the station, leaving about 20,000, which were distributed later. The losses during the summer were from ordinary causes.

It may be of interest to note that 900 people from all over the United States registered in the visitors' book, and were keenly interested in observing the methods used in the rearing of the fish.

*Amherst Rearing Station.*

A tract of land in the town of Sunderland, bordering on the State highway running from Amherst to Sunderland, was leased by the Commissioners from Fred Graves for a term of three years with an option of purchase.

On this tract are several large springs which have an even flow and an unchanging temperature of 45 degrees all the year round. There is no watershed to send down flood water, and the location appears to be ideal for a rearing station. A trolley line passes the property, and there are two railroad stations in Amherst and one in South Deerfield where fish and supplies can be shipped.

The same general plans of construction as at the Montague station were followed here, to supply a system of twenty-four nursery pools.

The station was sufficiently finished to receive fish on September 1, and 18,000 trout were shipped here from the Sutton Hatchery. Twice a day the fish were fed on liver, until on October 25 and November 2 they were distributed in the streams in Hampshire County in good condition.

The establishment of this station, like that of Montague, is more or less experimental. A thorough test of each will be made. At least two years' experience is desired with each station.

*Andover Rearing Station.*

The work of the Andover rearing station is covered in the discussion of Chinook salmon.

*Fish Distribution*

| County. | Brook Trout. | | | Rainbow Trout (Fingerlings). | White Perch (Adults). | Yellow Perch (Fry). | Small-mouth Black Bass. | | Large-mouth Black Bass (Fingerlings). | Land-locked Salmon. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fry. | Fingerlings. | Adults. | | | | Fry. | Fingerlings. | | Adults. | Fingerlings. |
| Barnstable, . | – | – | 900 | 16,000 | 1,000 | – | 4,800 | 11,975 | 17,400 | – | 5,000 |
| Berkshire, . | 159,000 | 44,950 | 1,000 | 2,400 | 7,600 | 3,400,000 | – | 16,950 | 14,900 | 225 | 5,000 |
| Bristol, . . | – | 33,000 | 200 | 6,000 | 2,940 | 750,000 | 9,000 | 4,500 | – | – | – |
| Dukes, . . | – | – | – | – | – | – | 24,000 | 800 | 1,200 | – | – |
| Essex, . . | 144,000 | 50,750 | 1,000 | – | 6,000 | 2,100,000 | 28,000 | 1,975 | 2,400 | 450 | 7,000 |
| Franklin, . | 170,000 | 26,200 | 200 | 1,350 | 3,720 | 500,000 | 16,000 | 500 | 4,200 | – | – |
| Hampden, . | – | 26,450 | 300 | 7,500 | 8,170 | 2,400,000 | 28,500 | 4,140 | – | 225 | – |
| Hampshire, . | – | 45,800 | 450 | – | 5,720 | 1,000,000 | – | 600 | 2,100 | – | – |
| Middlesex, . | 351,000 | 97,550 | 600 | – | 9,720 | 200,000 | 32,000 | 2,600 | 7,800 | – | – |
| Nantucket, . | – | – | – | – | – | – | – | – | – | – | – |
| Norfolk, . . | 24,000 | 25,350 | 400 | – | 6,000 | 1,500,000 | 16,500 | 600 | 3,200 | – | – |
| Plymouth, . | – | 25,250 | – | 6,000 | 6,500 | 750,000 | 35,000 | – | 3,210 | 225 | 6,000 |
| Suffolk, . . | – | – | – | – | 720 | – | 4,500 | – | – | – | – |
| Worcester, . | 471,000 | 268,650 | 1,245 | 5,000 | 18,360 | 3,400,000 | 45,500 | 1,500 | 4,200 | – | 5,000 |
| Other distributions.[1] | – | – | – | – | 720 | – | 550 | – | 275 | – | – |
| Totals, . | 1,319,000 | 643,950 | 6,295 | 44,250 | 77,170 | 16,000,000 | 244,350 | 46,140 | 60,885 | 1,125 | 28,000 |

[1] Indicates lots which have been shipped to other

*during the Year 1917.*

| Chinook Salmon. | | Fresh-water Smelt. | | Salt-water Smelt. | | Horned Pout (Fingerlings). | Pickerel (Adults). | Totals. | |
|---|---|---|---|---|---|---|---|---|---|
| Fry. | Fingerlings. | Eggs. | Adults. | Eggs. | Fry. | | | Eggs. | Fish. |
| – | 33,000 | 7,000,000 | 1,000 | 13,500,000 | 300,000 | – | – | 20,500,000 | 391,075 |
| – | 29,575 | – | 300 | – | 600,000 | – | 150 | – | 4,282,050 |
| – | – | 5,000,000 | – | 5,000,000 | – | – | – | 10,000,000 | 805,640 |
| – | – | 1,000,000 | – | 3,000,000 | – | – | – | 4,000,000 | 26,000 |
| 192,000 | 196,000 | 11,000,000 | 5,000 | 11,250,000 | – | – | – | 22,250,000 | 2,734,575 |
| – | – | – | – | – | – | – | – | – | 722,170 |
| – | – | – | 35,000 | – | – | – | – | – | 2,510,285 |
| – | – | – | – | 2,000,000 | – | – | – | 2,000,000 | 1,054,670 |
| – | – | 8,000,000 | 6,000 | 5,000,000 | – | 1,100 | – | 13,000,000 | 708,370 |
| – | – | – | – | – | – | – | – | – | – |
| – | – | – | – | 1,500,000 | – | – | – | 1,500,000 | 1,576,050 |
| – | 20,500 | 3,000,000 | 4,500 | 14,500,000 | – | – | – | 17,500,000 | 857,185 |
| – | – | – | – | – | – | – | – | – | 5,220 |
| – | 40,000 | 1,000,000 | 10,200 | 5,000,000 | 150,000 | 900 | – | 6,000,000 | 4,421,555 |
| – | – | – | – | 2,000,000 | – | – | – | 2,000,000 | 1,545 |
| 192,000 | 319,075 | 36,000,000 | 62,000 | 62,750,000 | 1,050,000 | 2,000 | 150 | 98,750,000 | 20,096,390 |

State commissioners as an interchange of courtesies.

## ENFORCEMENT OF LAWS.

One of the beneficial effects of the present war conditions may be described as the literal forcing on the general public of a better-balanced understanding as to how important a part of our national assets is the stock of wild life. We have wakened to the fact that as we work for our livelihood there is going on around us the reproduction of a vast number of wild forms which, under the guidance of reasonable laws, may be appropriated to our use for entertainment, clothing and food, to say nothing of many other purposes. To-day comparatively little is done to assist this reproduction. This is all the more reason why we should broaden out our efforts, proceeding on the theory that what we now have is our brood-stock. Our problem will be in a large measure the determining of such restraint or guides as will enable us to keep that stock intact, but at the same time to utilize a substantial part of the yearly increase. This argument suggests what we believe to be true, — law enforcement is very largely a matter of education. The Commission would much rather be instrumental in convincing a man that the regulations are for his benefit, and thus make him a worker in the cause, than in arresting and subjecting him to a heavy fine for refusal to observe the regulations. For this reason a special appeal is made directly to every resident of Massachusetts, asking him to assist the local deputies in the enforcement of the laws, to give him every encouragement in carrying on his work, to get acquainted with him personally, and not believe every slanderous story which is circulated by his enemies to injure his reputation.

The Commissioners take this occasion to recognize the fine spirit in which the deputies have taken hold of the changes in the present administration. It is this spirit of mutual co-operation which each individual warden feels toward the Commission as a whole, and particularly the special pride which he takes in his own district, that is stimulating and benefiting the whole work. Nevertheless, there is abundant room for improvement. Special study has been given to the effective-

ness of a merit system among the deputies whereby the men will receive certain credits for all work accomplished, and in this way a premium will be placed on individual initiative.

The table of classified arrests on the pages following summarizes the year's work. The total number of apprehensions was 384, of which 355 resulted in convictions, an increasing proportion over previous years, and a silent tribute to the efficiency of the workers.

## Deputy Force.

During the past year a system of keeping track of the location of the deputies at all times has been tried with beneficial results, although the problem has not as yet been fully solved, and certain changes are necessary before the system will operate smoothly.

The changes in the personnel of the force during the past year have been as follows: Elisha T. B. Ellis of North Easton, formerly an unpaid deputy who had done special work for the Commission, and who stood highest on the list of eligibles presented by the Civil Service Commission, was appointed to the position of district deputy. The resignations of Deputy Allan Keniston of District No. 2, and Deputy William Day of Marthas Vineyard, who enter other fields of work, were accepted with regret. It is a pleasure to report that Deputy Peter P. Monahan has entirely recovered from a serious fracture of the spinal vertebræ, received in the performance of his official duties. On Aug. 13, 1917, occurred the death of Irving O. Converse of Fitchburg, Mass., who had been in the service of the Commission as district deputy for over ten years. Mr. Converse leaves behind a record for faithful, honest and intelligent work in his chosen field, and a host of friends in his district who join with his fellow workers in expressing their regard, esteem and friendship for one whose life was well spent, and whose influence will long be felt.

## Problems.

Some of the problems of increased efficiency in the apprehension of violators on land and water are still unsolved. The automobile on land and the fast power boat on the water enable

violators to escape from deputies who are unprovided with means to cope with them. The principal need at the present time is a "flying squadron" equipped with an automobile, which can be sent into the various districts as occasion demands. Ultimately it will be necessary to thus equip every deputy, but at the present time the services of even a few machines would be invaluable. Many times the use of an automobile makes possible the speedy cleaning up of jobs on which it would be too late to secure evidence if the deputies were obliged to depend upon the ordinary modes of travel. A case in point occurred in the Berkshires just before the opening of the deer season. Information was secured that a deer had been killed. By use of the telephone assistance was summoned, an automobile procured and deputies were soon on the scene. So secure did the violators feel that the deputies found them working by lantern light, and were able to get near enough to hear the conversation. The offenders were arrested, tried next morning and paid fines of $200. In addition two non-resident and two resident hunters' licenses were revoked. It is needless to say had the deputies waited for ordinary means of transportation there would have been no chance of securing direct evidence and the resulting convictions. The department of law enforcement possesses two Ford cars at the present time. Unfortunately, an act of the Legislature, passed in 1917, requires that cars owned by the Commonwealth shall bear on special number plates, in letters 1½ inches high, the words, "The Commonwealth of Massachusetts," and, in the case of this department, "F. &. G." Thus heralded and announced the deputy starts his work under a handicap, as violators may be warned of his approach either by actual sight or by the kindly disposed friends with telephones, so numerous in the country. If automobiles are ever to be of full value in law enforcement, a special waiver of this act must be made in so far as it affects the Fish and Game Commission. It is a well-known fact that when deputies appear in a district word is passed ahead, and for that reason the greatest secrecy is necessary in all the department's work. As an illustration of the difficulty arising from a conveyance becoming too conspicuous may be cited the recent instance of a motorcycle and side car,

which, as a result of becoming too well known in one district, had to be transferred to another.

A speedy shallow-draft power boat of the semi-cruiser type would make possible the arrest of numerous violators. To illustrate the importance of the violations on salt water may be cited the instance of 22 Italian fishermen who were fined $100 each in the Quincy courts, or a total of $2,200, the largest fine ever imposed in a fish and game case taken before the Massachusetts courts. It is this type of violator of laws pertaining to the commercial fisheries that must be restrained if we are to preserve the natural supply for future generations, and in certain cases this can be effectively done only through the agency of a fast power boat.

## Annual Meetings.

The annual meetings of the deputy force, at which the local and general problems of law enforcement and the recommendations of the various deputy commissioners are discussed, have proved very satisfactory. Semi-annual meetings of this sort would prove even better for purposes of instruction and for bringing about a greater degree of co-operative service.

## Town Wardens.

Approximately the same number of town wardens as last year have been in service. The value of this branch of the service is rather in the moral effect on the community, and the resulting tendency of the chronic violators to give up their illegal work, than in the actual arrests. While good reports have been received from these wardens, but few arrests have been recorded.

## Federal Wardens.

Eight of the district deputies of the Commission have received appointments as Federal wardens. To the list published in the last report should be added the name of Deputy William W. Sargood of Lee.

### The Game Warden as an Educator.

The work of the game warden does not necessarily consist in making numerous arrests, but rather in so organizing his district that violations of the fish and game laws are made more difficult by reason of fear of detection, and also by guiding the sentiment of his community toward a proper appreciation of their importance. In the latter respect the district deputy is an educator in fish and game conservation. His position is a responsible one in his community, and upon him rests the responsibility of teaching the boys and girls to become preservers and not destroyers of nature. Certain district deputies have shown considerable talent for lecturing, and have given numerous talks upon the work before various local clubs, schools and Boy Scout associations. In addition to these lectures the district deputies are always ready and willing to explain by personal interview matters relating to fish and game.

Between January and May the chief deputy delivered 25 stereopticon lectures before bird clubs, Boy Scouts and fish and game associations. These lectures, mostly at night, in various parts of the State, required considerable traveling and late night work. The greater part of these talks were of a general nature relating to the various activities of the Commission.

### Exhibits.

The district deputies have always been greatly interested in the various exhibits which have been given by the Commission from time to time in their districts, and of which they have usually had charge. During 1917 the number and size of these exhibits had to be curtailed owing to the fact that quail and grouse do not stand confinement in exhibition cages, and pheasants are not in good plumage during the exhibition season.

### Posters.

The demand for posters and law books becomes greater each year. More people are desirous of obtaining correct information regarding the regulations on fishing and hunting. The

deputy in each district serves as a clearing center for the distribution of posters and law books. In 1917, 50,000 post cards, 7,000 posters and 15,000 books, giving the full changes in fish and game laws made from 1916 to 1917, were distributed.

## Licenses.

Each year the reasonableness of the combination hunting and fishing license becomes more evident. In fairness to the hunter the fisherman should help bear the burden of contributing to the support of the cause. Other States have adopted some such a measure as the combined hunting and fishing license, and the time is not far distant when Massachusetts will follow their lead.

Under chapter 614, Acts of 1911, as amended by chapter 379, Acts of 1912, chapters 249 and 479, Acts of 1913, and chapter 212, General Acts of 1915 every resident native or naturalized citizen can obtain from any town or city clerk a hunting license for the amount of $1. The influence of the license system on law enforcement is especially beneficial from the standpoint of the deputies, for the reason that the alien hunter is more readily handled and the prospect of losing a license is a greater check upon the potential violator than the fear of arrest and fine.

## Recent Legislation.

The principal changes in the laws are briefly: —

1. The licensing of lobstermen in the shore towns, beginning Nov. 1, 1917, will prove of assistance to the deputies and a protection to the lobstermen.

2. Limiting the catch of trout to 25 to any one person in a day's catch will have a beneficial effect on the well-stocked streams, where greater numbers might readily be taken.

3. The open season on upland birds and game will commence November 1 instead of October 12.

## Needed Legislation.

The following changes would be beneficial: —

1. Laws regarding the catching of herring in Boston Harbor by torches and seines should be made uniform for the entire

harbor. At the present time at least seven sections of the coast have different regulations.

2. Uniform lobster laws in the Atlantic coast States and Canada would be of great assistance in handling the shipments at Boston, and would tend to conserve the supply of small lobsters.

3. Further legislation is needed to protect the smelt streams, particularly the Weir and Weymouth rivers, and a hatchery should be established to furnish smelt for stocking the inland waters.

*Classified Court Records, 1917.*

| Violation. | Fines. | | Costs of Court. | Disposition of Case. | | | | Number of Cases. |
|---|---|---|---|---|---|---|---|---|
| | Imposed. | Paid. | | Discharged. | Convicted. | Appealed. | Filed. | |
| Alien, | $1,110 | $760 | - | - | 33 | 5 | 8 | 33 |
| Assault on officer, | 5 | - | - | 1 | 3 | 3 | - | 4 |
| Interfering with officer, | 5 | 5 | - | - | 1 | - | - | 1 |
| *Birds.* | | | | | | | | |
| Birds protected at all times, | 180 | 115 | - | 2 | 14 | 1 | 3 | 17 |
| Quail, closed season, | 20 | 20 | - | - | 1 | - | - | 1 |
| Partridge, closed season, | 90 | 90 | - | - | 5 | - | - | 5 |
| Pheasants, closed season, | 20 | 20 | - | 1 | 2 | - | - | 3 |
| Waterfowl, closed season, | 60 | 40 | $9 87 | - | 11 | - | 6 | 11 |
| Unlawfully dealing in trade with game birds. | 240 | - | - | 2 | 1 | 1 | 1 | 3 |
| *Game.* | | | | | | | | |
| Deer, closed season, | 365 | 315 | - | 2 | 10 | - | 2 | 13 |
| Carrying rifle in closed season on deer. | - | - | - | 1 | - | - | - | 1 |
| Unlawfully selling deer, | 20 | 20 | - | - | 1 | - | - | 1 |
| Rabbits, closed season, | 15 | 15 | - | - | 3 | - | - | 3 |
| Squirrels, closed season, | 50 | 50 | 5 00 | 1 | 6 | - | 1 | 7 |
| Exposing poison for birds and animals. | 20 | 20 | - | - | 1 | - | - | 1 |
| *Hunting.* | | | | | | | | |
| Hunting without license, | 525 | 435 | 29 80 | 2 | 52 | 3 | 10 | 55 |
| Hunting on posted land or reservation. | 80 | 80 | 15 60 | - | 12 | 1 | 1 | 14 |
| Hunting on Lord's Day, | 245 | 200 | 17 80 | 4 | 20 | 1 | 6 | 26 |
| Hunting with use of motorboat, | - | - | - | 1 | - | - | - | 1 |
| Hunting with use of automobile, | 10 | 10 | - | - | 1 | - | - | 1 |

*Classified Court Records, 1917* — Concluded.

| Violation. | Fines. Imposed. | Fines. Paid. | Costs of Court. | Disposition of Case. Discharged. | Convicted. | Appealed. | Filed. | Number of Cases. |
|---|---|---|---|---|---|---|---|---|
| *Trapping.* | | | | | | | | |
| Failure to visit trap once in twenty-four hours. | 15 | 15 | – | – | 2 | – | – | 2 |
| Trapping without permit, | 5 | 5 | 1 90 | – | 2 | – | 1 | 2 |
| Taking by illegal traps, snares, etc., | 55 | 40 | – | – | 4 | 1 | – | 4 |
| Transferring license, | – | – | – | 1 | – | – | – | 1 |
| Carrying firearm without permit, | 100 | – | – | – | 2 | 1 | – | 2 |
| *Fish.* | | | | | | | | |
| Bass, closed season, | 25 | 25 | – | – | 3 | – | – | 3 |
| Bass, short, | 23 | 23 | – | – | 3 | – | – | 3 |
| Herring, without permit, | 3 | 3 | – | – | 1 | – | – | 1 |
| Herring, destroying, | – | – | – | 1 | – | – | – | 1 |
| Lobsters, short, | 2,379 | 1,530 | 6 00 | 1 | 42 | 1 | 8 | 44 |
| Lobsters, egg-bearing, | 244 | 244 | – | – | 6 | – | 1 | 6 |
| Interfering with lobster traps, | – | – | – | 1 | – | – | – | 1 |
| Illegal marking of lobster car, | 60 | 45 | – | – | 5 | – | – | 5 |
| Setting lobster trap by a person not a citizen. | 20 | 20 | – | – | 1 | – | – | 1 |
| Perch, short, | 65 | 65 | – | – | 7 | – | – | 7 |
| Mackerel, seining, | 40 | – | – | – | 5 | – | – | 5 |
| Mackerel, underweight, | 100 | – | – | – | 5 | – | – | 5 |
| Smelt, closed season, | 30 | 30 | 20 00 | – | 16 | – | 3 | 16 |
| Trout, short, | 120 | 100 | – | – | 13 | 1 | 1 | 13 |
| Clams, without permit, | – | – | 3 72 | – | 3 | – | 3 | 3 |
| Fishing other than by hook or line, | 300 | 300 | 10 00 | – | 17 | – | – | 17 |
| Seining, | 2,880 | 60 | – | – | 34 | 30 | – | 34 |
| Torching, | 100 | – | – | – | 2 | 2 | 1 | 2 |
| Maintaining fish trap without permit, | 100 | – | – | – | 2 | 1 | 1 | 2 |
| Fishing with more than ten hooks, | 40 | 40 | – | – | 2 | – | – | 2 |
| Larceny of auto used for State work, | – | – | 4 50 | – | 1 | – | 1 | 1 |

*Summary.*

| | |
|---|---|
| Number of cases, | 384 |
| Fines imposed, | $9,764 00 |
| Fines paid, | $4,740 00 |
| Costs of court, | $124 19 |
| Cases discharged, | 21 |
| Cases convicted, | 355 |
| Cases appealed, | 52 |
| Cases filed, | 58 |
| Number of laws violated, | 46 |

## FISHWAYS.

### Merrimack River Fishways.

The success of the introduction of the Pacific salmon (Chinook) into the coastal waters depends upon the presence of fishways at Lawrence and Lowell. In addition, this great river system should be made a great breeding ground for other anadromous fish, particularly the alewife. This can never be realized until means are provided to enable the fish to surmount the dams at the above cities. There are fishways at both points to-day, but they are in such a dilapidated condition or so inadvisedly located as to be of no help to the fish.

During the past few years the Board has had under consideration the question of rebuilding and relocating these ways, which has been a subject of much discussion among the fishermen and sportsmen of the Merrimack Valley. The Lowell Fish and Game Association has earnestly advocated it. Without going into the history of these fishways, all of which appears in the reports of the department, it is sufficient to say there has been much legislation and some litigation in respect to the one at Lawrence. It turns mostly on the extent to which the Essex Company (which owns the dam) is obligated to build and maintain a fishway. The records indicate that the Essex Company has always been ready and willing to do all that could be reasonably asked of them. As to the one at Lowell, it appears that the Locks and Canal Company is obligated to maintain a way, and that this company has likewise been ready at all times to do its part.

The Board has now started to effect the location at these points of fishways of the most effective type now known. As the first step it seemed advisable to ascertain beyond question the legal obligations of all parties in interest. The Board laid the matter before the Attorney-General on June 21, 1917, and the following correspondence resulted: —

BOSTON, June 21, 1917.

Hon. HENRY C. ATTWILL, *Attorney-General of the Commonwealth, State House, Boston, Mass.*

DEAR SIR: — According to chapter 289, Acts of 1856, it appears that the Essex Company, which operates the Lawrence Mills at Lawrence, Mass., was obligated to maintain in and around its dam at Lawrence a suitable and sufficient fishway for a certain period of each year.

We herewith request your opinion as to whether or not previous or subsequent legislation on this point has modified in any respect this obligation on the part of the Essex Company to maintain said fishway.

Should it appear from your investigation that this company is still bound by this act, may we ask whether the Fish and Game Commission, pursuant to section 12, chapter 91, Revised Laws of 1902, is the proper agent to institute proceedings, if necessary, to see that this fishway is restored (the same being now in decay and of no practical value), or whether the proceedings should be instituted by you on behalf of the Commonwealth.

Thanking you for your attention to the foregoing in due course, we are,

Very truly yours,

WILLIAM C. ADAMS,
*Chairman.*

BOSTON, June 21, 1917.

*Essex Company, Lawrence, Mass.*

GENTLEMEN: — We have this day applied to the Attorney-General for instructions relative to the existing legal obligations on your part to maintain a fishway around the dam at Lawrence. After this matter has been fully decided as to what are the existing legal requirements, we will take the whole subject up with you.

We aim during the coming period of low water to make a thorough investigation of the situation to see what is the most desirable thing to do in the establishment of a fishway at this dam.

Our object by this letter is to keep you in touch with the situation, and to assure you now that it is not our intention to invoke any legal measures whatever until our board and your company have had an opportunity to carefully consider the matter to see what is the best thing to do.

If it appears that you are under a legal obligation to instal this fishway by reason of special legislation passed years ago, or if it appears that, without such legislation, in the opinion of our board it is advisable that this fishway be established, we will endeavor to co-operate with you to the fullest extent possible in the construction of such a fishway, in order

that an effective and satisfactory one can be put up at the minimum expense to you.

We feel satisfied that we will receive a hearty response from you in our efforts along this line, and we will keep you in touch from time to time with our plans as they mature.

Very truly yours,

William C. Adams,
*Chairman.*

Department of the Attorney-General,
Boston, Oct. 2, 1917.

Mr. William C. Adams, *Chairman, Commissioners on Fisheries and Game.*

Dear Sir: — I beg to acknowledge your favor of June 21, 1917, in which you ask my opinion on the following facts: —

According to chapter 289, Acts of 1856, it appears that the Essex Company, which operates the Lawrence Mills at Lawrence, Mass., was obligated to maintain in and around its dam at Lawrence a suitable and sufficient fishway for a certain period of each year.

We herewith request your opinion as to whether or not previous or subsequent legislation on this point has modified in any respect this obligation on the part of the Essex Company to maintain said fishway.

Should it appear from your investigation that this company is still bound by this act, may we ask whether the Fish and Game Commission, pursuant to section 12, chapter 91, Revised Laws of 1902, is the proper agent to institute proceedings, if necessary, to see that this fishway is restored (the same being now in decay and of no practical value), or whether the proceedings should be instituted by you on behalf of the Commonwealth.

The Essex Company was created a corporation by St. 1845, c. 163, for the purpose of constructing a dam across the Merrimack River and building one or more locks and canals in connection with said dam for the purpose of creating a water power to use or sell or lease to other persons or corporations to use for manufacturing and mechanical purposes, and for constructing a main canal for navigation.

Section 5 of this act required the company to make and maintain in the dam so built by it across said river suitable and reasonable fishways, to be kept open at such seasons as are necessary and usual, for the passage of fish.

Section 7 of this act required the company to build such fishways in the mode prescribed by the county commissioners, after due notice and a public hearing of all parties interested, with power to the commissioners to examine and determine whether the fishways had been built according to such mode prescribed, and if so to accept the same.

By St. 1848, c. 295, the company was authorized to increase its capital stock, but upon an express condition, which is as follows: —

That said company shall be liable for all damages which shall be occasioned to the owners of fish rights existing above the said company's dam by the stopping or impeding the passage of fish up and down the Merrimack River by the said dam.

This act contained a further proviso that nothing contained in the seventh section of the act of incorporation — the section requiring the company to make and maintain fishways — should be deemed to be a bar to such claim for damages.

St. 1848, c. 295, further provided that it should take effect whenever the stockholders of the company at a legal meeting should accept the provisions of section 1 of the act.

By St. 1856, c. 289, the company was required to make and forever maintain in and around its dam in Lawrence a suitable and sufficient fishway for the usual and unobstructed passage of fish during certain months in every year. Heavy penalties were prescribed for failure to comply with the provisions of this act. Complaints frequently arose, and the company was indicted for failing to comply with the provisions of this statute. The case was carried to the Supreme Judicial Court on exceptions, and is reported under the title of Commonwealth *v.* Essex Company, 13 Gray, 239.

The exceptions were to the refusal of the court to admit certain evidence offered to be proved by the defendant, which would show, among other things, that the Essex Company had applied to the county commissioners, under the original act of 1845, requesting them to prescribe a mode in which it should construct fishways in its dam; that notice was thereupon given and a hearing held, and the commissioners prescribed the mode and plan in which the company should construct fishways; that thereafter the company constructed the fishways in its dam in accordance with the method prescribed by the commissioners, but that said fishways, as constructed, proved to be unsuitable and insufficient to provide a convenient passage for the fish; that at the time of the passage of St. 1848, c. 295, the character of said fishways, as not affording a usual and unobstructed passage to fish, was well known, and was brought to the notice of the Legislature; that immediately after the passage of said act the Essex Company paid, under said act, the sum of about $26,000 to the owners of fish rights above said dam as damages for hindering or impeding the passage of fish by said dam with the fishways.

In an exhaustive opinion by Chief Justice Shaw it was held by the court that if the facts offered to be proved by the defendant should appear to be true, St. 1848, c. 295, constituted a contract between the Commonwealth and the Essex Company, by which it was not required to maintain fishways other than those previously prescribed by the county commissioners, and that the Legislature could not thereafter require the company to make different fishways, notwithstanding R. S., c. 44, § 23, reserving to the Legislature the right to amend, alter or repeal charters granted by the Legislature.

No attempt thereafter was ever made by the Commonwealth to retry the case, and so I think it is to be assumed that the Commonwealth at the time was satisfied that the facts offered to be proved by the defendant were true. Furthermore, several statutes later were passed in which the Commonwealth seemed to recognize that a contract existed between the Commonwealth and the Essex Company, authorizing the Essex Company to maintain its dam as originally constructed.

Among these are St. 1866, c. 238, which authorized the Governor and Council to appoint two commissioners, to be known as Commissioners of Fisheries in the Merrimack and Connecticut rivers. These commissioners were authorized to determine the mode and plan by which fishways were to be erected in the dams of the Merrimack and Connecticut rivers, and in case of the neglect or refusal of a proprietor to build a fishway in accordance with the plan prescribed by the commissioners, they were empowered to contract for the building of the fishway in question at the expense of the proprietor of the dam.

By section 10 of this act the commissioners were authorized to contract with the Essex Company for the construction of a fishway, as prescribed by said commissioners, over the dam of the company at Lawrence, by said company, at an expense to the Commonwealth not exceeding $7,000, the said Essex Company to pay the expense of such building over and above the amount so to be paid by the Commonwealth. A troughway on Foster's plan was put up to care for the passage of the fish at a cost of $8,500, whereof $3,500 was paid by the Essex Company, with a further agreement to pay one-half the cost of maintenance for five years.

St. 1869, c. 384, entitled "An Act for encouraging the cultivation of useful fishes," increased the number of commissioners to three, to be known as the Commissioners on Inland Fisheries. This act gave the commissioners substantially the same powers as were given the commissioners appointed under St. 1866, c. 238, in dealing with proprietors of dams who were required by law to build and maintain fishways in their dams.

St. 1869, c. 422, gave the Supreme Judicial Court jurisdiction in equity to compel the proprietors of dams in Massachusetts on the Merrimack and Connecticut rivers to construct and erect fishways on, over and around dams where said proprietors had failed to comply with the provisions of St. 1866, c. 238.

St. 1876, c. 50, extended the provisions of St. 1866, c. 238, and St. 1869, c. 422, to the tributaries of the Merrimack and Connecticut rivers within this Commonwealth.

These various statutes to which I have referred appear substantially in R. L., c. 91, § 12, as amended by St. 1904, c. 365, which is as follows: —

If, in the opinion of the commissioners, a passage for edible fish should be provided, or if any one of the commissioners finds that there is no fishway or an insufficient fishway in or around a dam where a fishway is required by law to be maintained, any one of the commissioners may, in his discretion, enter with work-

men and materials upon the premises of the person required to maintain a fishway there, and may, at the expense of the commonwealth, if in the opinion of the commissioners the person required by law to construct or maintain such fishway is not able to afford such expense, improve an existing fishway, or cause one to be constructed if none exists, and may, if necessary, take the land of any other person who is not obligated by law to maintain said fishway; and if a fishway has been constructed in accordance with the provisions of this section, the commissioners shall not require the owner of the dam to alter such fishway within five years after the completion thereof.

In the report of the Commissioners on Inland Fisheries for the year ending Jan. 1, 1876, entitled Senate No. 24, the matter of altering the fishway at Lawrence was discussed at some length, as it appeared that the fishway must be relocated to be of any use in assisting fish in the passage of the dam. Apparently, the commissioners were doubtful as to their authority to compel the Essex Company to do this work or to contribute to the cost of the same. This is evident from the following language in the report: "The State, having by unwise legislation parted with more or less of its rights in the charter granted to the Essex Company, it followed that whatever expenses were incurred in this alteration must be borne by the Commonwealth."

It appears that substantial alterations were made, as the expenditures of the commissioners for the year ending Jan. 1, 1876, show that the sum of $1,848.28 was spent for improvements at the Lawrence fishway. From the commissioners' report for the year ending Jan. 1, 1877, entitled Senate No. 8, it appears that the sum of $1,906.33 was spent in further improvements at the Lawrence fishway. The commissioners' report states that owing to the generosity of the Essex Company, which contributed $500 towards the fishway, the work was completed.

Subsequent reports of the commissioners show that from time to time the Commonwealth expended various sums for labor and repairs at the Lawrence fishway. In at least one instance one-half the expense for repairing the fishway was borne by the Essex Company.

By the Resolves of 1897, chapter 53, a sum not exceeding $2,500 was appropriated, to be expended under the direction of the Commissioners on Inland Fisheries, for the payment of one-half the expenses of repairs on the fishway over the Lawrence dam. In the report of the Commissioners on Inland Fisheries for the year ending Dec. 31, 1898, entitled Public Document No. 25, it appears from the following language that improvements were made at the Lawrence fishway: —

Two years ago the old fishway had been carried away by freshets. The Legislature appropriated $2,500 in part payment for rebuilding the Lawrence fishway, the Essex Company paying the other half. Upon consultation with Mr. Mills, chief engineer of the Essex Company, it was decided to build it on the opposite side of the river from the old one, as being less likely to be affected by freshets and not so expensive to keep in repair. The work has been well and thoroughly done, and the fishway is in good working order at less cost than was first estimated. Of the $2,500 appropriated, about $1,000 reverts to the State.

The case of *Commissioners on Inland Fisheries* v. *Holyoke Water Power Company*, 104 Mass. 446, is to be distinguished from *Commonwealth* v. *Essex Company*, 13 Gray, 239.

The Holyoke Company derived its charter from St. 1859, c. 6, and was the owner, by purchase, of the dam at Holyoke, which it bought from the Hadley Falls Company, a corporation which erected the dam in accordance with the authority conferred upon it by its charter (see St. 1848, c. 222).

In differentiating between these two cases the court said, in the Holyoke case, that —

> It not only appears that there are fishing rights below, which are injured by the dam, and for the injury to which no compensation has ever been made or provided; but no fishway whatever has been constructed; and the Legislature has never, before passing the statute now sought to be enforced, exercised the power of defining what fishway defendants should make; nor has it ever authorized or approved, by any expression or implication, the construction or maintenance of a dam without a fishway. In all these respects this case differs from that of the Essex Company.

In view of the foregoing history of proceedings in relation to fishways at the Essex Company's dam, I do not think that it could now be successfully contended by the Commonwealth that the facts offered to be proved by the defendant in the case of *Commonwealth* v. *Essex Company* were not true.

Accordingly, I feel constrained to advise you that I am of the opinion that the provisions of St. 1856, c. 289, have no application to the dam of the Essex Company, nor do any acts subsequently passed requiring fishways have any application thereto unless the Essex Company has voluntarily bound itself by contract to construct or maintain at its dam fishways other than those required by St. 1845, c. 163. So far as I am advised no such contract exists. Whether the Essex Company can now be required to reconstruct and maintain fishways as prescribed by the county commissioners under the provisions of St. 1845, c. 163, I deem it unnecessary to determine, as I understand such fishways would not now be satisfactory if reconstructed and maintained.

Very truly yours,

HENRY C. ATTWILL,
*Attorney-General.*

BOSTON, Oct. 24, 1917.

*Board of County Commissioners, Salem, Mass.*

GENTLEMEN: — On June 21, 1917, we wrote a letter to the Attorney-General relative to establishing the responsibility for constructing and maintaining fishways in the Merrimack River around the dams at Lawrence and Lowell. We have also received a reply from the Attorney-General on the same proposition.

We enclose herewith for your information copies of this correspondence. The Attorney-General seems to think there may have been some contract or agreement between the county commissioners of Essex County and the Essex Company as a result of which the liability of the Essex Company may be fixed. Or it is barely possible by these negotiations the Commonwealth has released the Essex Company from any obligations to install and maintain such fishways.

We would appreciate it if you would consult your records during and subsequent to 1845, and advise us as to what they disclose relative to any negotiations with the Essex Company on this point.

In view of the fact that this is the period of low water, it would be desirable to have this information from you as early as you can conveniently work it up.

Very truly yours,

William C. Adams.
*Chairman.*

Office of the County Commissioners,
County of Essex, Salem, Oct. 29, 1917.

Hon. William C. Adams, *Chairman, Commissioners on Fisheries and Game, Boston, Mass.*

Dear Sir: — Acknowledging yours of October 24 regarding the fishway at the dam in Lawrence, I have to advise you that I am unable to find anything in our records that sheds any further light on the subject-matter than is already referred to in the enclosure on page 3 thereof, *i.e.*, that the company applied to the commissioners requesting them to prescribe the mode and plan; that the fishways were constructed in accordance with the methods prescribed by the commissioners, etc.

For the commissioners,

Yours very truly,

Moody Kimball,
*Chairman.*

Boston, Oct. 30, 1917.

Hon. Henry C. Attwill, *Attorney-General of the Commonwealth, State House, Boston, Mass.*

Dear Sir: — We are enclosing, for your information, copy of a letter just received from the county commissioners of Essex County, in reply to our request that they search their records for data relative to any negotiations with the Essex Company.

From this it appears that we are unable to obtain for you any additional data relative to the effect that contracts may have had on the status of the Essex Company with relation to its obligations to the Commonwealth to maintain the fishway.

May we ask you to make such additional investigation as you can and give us your opinion as to who is obligated to install and maintain the fishways around the dams at Lawrence and Lowell. This is the period of low water, and we would like to have this matter in shape so that we can take such action as appears to be advisable at an early date.

Very truly yours,

William C. Adams,
*Chairman.*

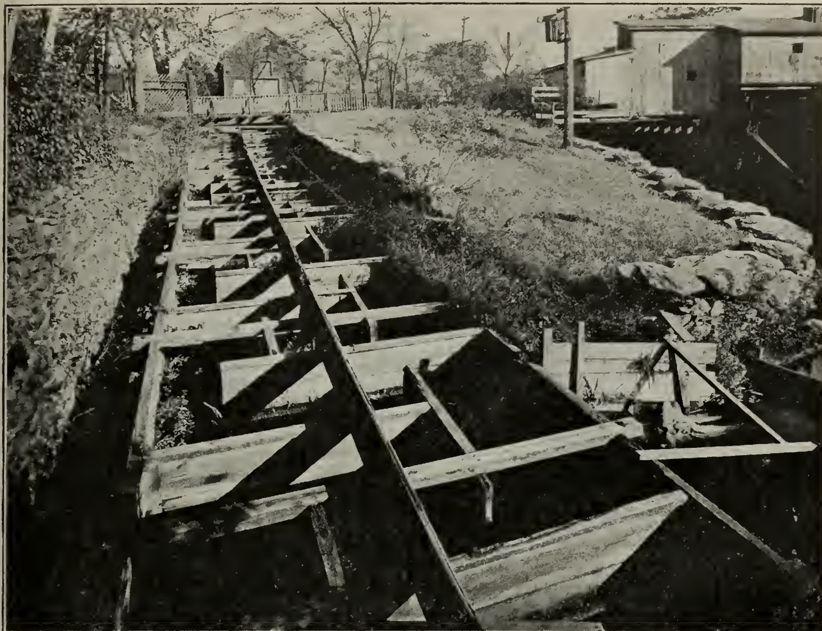
It is obvious that a considerable amount of investigation and research will have to be made by the Attorney-General in order to collect all the facts. Several conferences have been held with representatives of the Essex Company, and they have assured the Board of the desire of the company to co-operate in this undertaking.

Nothing substantial can be done until the opinion of the Attorney-General has been received, and until the Legislature has provided funds. In the budget for the coming year an appropriation of $15,000 has been asked with which to do this work.

## The East Taunton Fishway.

As a definite accomplishment in the development of the alewife fisheries the building of a new fishway by the Connecticut Mills Company, Inc., at East Taunton is cited. The famous old fish passage dates back to 1830, when it was first built, and has remained almost without alteration since that time. Of an old-fashioned Brackett type, the flow of water through it was so great as to prove a serious tax upon the energy of the ascending fish. Repairs were required annually to keep it working.

The obligation of maintaining the way rested upon the Connecticut Mills Company. Early in the year, as a result of certain construction work carried on at the plant, the river was lowered practically to the channel, leaving the fishway high and dry to one side, with the spring run of alewives almost at hand. The Board laid the situation before the officials of the company, stating what should be done to take care of the coming run, and outlining plans for a permanent fishway. A prompt response assured the Commissioners of the co-operation of the company.



Old fishway at the dam of the Connecticut Mills Company, Inc., East Taunton.

Fishway at the dam of the Connecticut Mills Company, Inc., East Taunton. Showing fishway as rebuilt in 1917.

The old fishway was temporarily put in repair, which enabled the fish to make their ascent of the river, and in the summer work was started on the permanent structure. As the result of a number of experiments upon the water flow made by representatives of the department, a modified and improved type of Brackett fishway was designed. A new arrangement of buffle boards provides a greatly increased number of rest pockets, an increase in depth of water of at least a foot, and a much less rapid flow. With these improvements it is believed that the fish can traverse the necessary distance in one-half the time formerly required. The company officials voluntarily laid plans to erect a set of screens across the intake leading to the turbine wheels, so as to prevent the passage of the young that way, with consequent injury, as they return to the sea. All the cost of the fishway and screens was paid by the company.

It is with pleasure that the Commissioners acknowledge the interest taken by the officials of the Connecticut Mills Company in this work, and it is sincerely to be hoped that their attitude will serve as a precedent to other owners of dams upon whom it may devolve to render like service. The many courtesies of Superintendent O'Gara deserve special mention.

## MARINE FISHERIES.

Remarkable under the unusual conditions prevailing have been the results of the deep-sea fisheries of the State for the year past, both as regards catch and value. Not only was the fleet catch greater than last year, but the values to the fishermen and fish shipping and curing concerns have not, with a few scattering exceptions, been exceeded in present memory.

That the catch should have been larger and prices also an advance over previous years would seem not a little paradoxical, but an analysis of conditions gives the answer.

In the first place, it should be borne in mind that the imports of staple lines of fish, such as have been received in large quantities from European maritime countries, are cut off. It should also be considered that of all fishing sections of the United States, Massachusetts was the only State in a position to report, at a recent fish dealers' conference at Washington, an increase in catch. Others reported a decrease of 15 and 25 per cent. in the catch of staple fish in their localities, and some a shortage of fully 50 per cent.

To the above statements add the fact that the consumption of fish in this country, which has for several years been rapidly growing, has recently been further increased by the "two-fish-days-a-week" propaganda of the Food Administration, and it at once becomes evident that, even if the fish landings of Massachusetts have increased some 10,000,000 or 15,000,000 pounds, such excess cannot in any appreciable measure make up for loss of importations and the large decrease in catches of other sections of the country. As in the case of other food lines, the increased demand with this isolated increased supply has made for higher prices.

Other reasons have also contributed to the increase in prices. Everything connected with the building or equipping of a fishing vessel, from hull to fishing gear, has advanced abnormally. The fishermen are now strongly unionized, and wages of all workers on fish, from wharf men to office help, have become higher. In some cases two and three raises of 10 per cent. each in a year have been made, not to mention an addi-

tional "bonus" of 10 per cent. paid, and all in addition to shorter working hours.

These statements are not made with the idea of justifying the present very high retail prices of fish of all kinds in some quarters, but merely to state some facts from which the reader may draw his own deductions. It must be evident, however, that with short supply and greatly increased demand the ex-vessel price of fish — as with the production price of practically all other food commodities — should be somewhat higher at present than when conditions are normal.

Let us consider some of the unusual conditions which have prevailed in the fisheries and fish business in this the first of the war years of this country.

### Some Problems of the War and the Fleet.

In the first place, the declaration of President Wilson that a state of war existed against Germany found the Massachusetts fishing fleet considerably depleted in numbers on account of the large number of fine fishing crafts that had been sold to Newfoundland and Nova Scotia at unusually high figures since England entered the war. This, notwithstanding the fact that during the past two years every available shipyard in Maine and this State, fitted for fishing vessel building, has been turning out crafts to the extent of their capacity and speed. As an indication of the great boom in the fisheries it is stated, by those in position to know, that the fishing-vessel shipyards now have contracts ahead that will keep them busy for almost two years.

On top of this shortage of sailing fishing craft the fish-producing industry in the early days of the war received another severe blow when four of the large steam otter trawlers hailing from Boston were sold to the Russian government. This was followed quickly by the action of the United States government in commandeering five more from the same steam otter trawling fleet, thus leaving to fishing uses but four of a fleet of thirteen large-trip, quick-fishing craft, which, when all thirteen were in fishing commission, it is estimated landed nearly 40 per cent. of all the fresh ground fish brought in at the Commonwealth Fish Pier at Boston in 1916. This shows at a glance

what condition the fishing fleet of Massachusetts was in to meet Mr. Hoover's edict that the fish catch of the country must be increased 50 per cent.

Nor was this all. In late years one of the greatest problems facing the vessel owners has been the fact that the number of fishermen has been insufficient. In fact, at times the past two years the fleet has been "men-shy." Since England entered the war many of the fishermen of Newfoundland and Canadian birth have gone home to enlist, while others enlisted in Boston. On the entry of the United States into the war many more fishermen, seized with the spirit of patriotism, as fishermen always have been when the United States went to war, enlisted at Boston and Gloucester in the navy or the Naval Reserve. Even many leading master mariners, imbued with the spirit of the sea, which combines pride of country with unrivaled fearlessness and daring and bravery, voluntarily answered the call to the colors, and are now in service as boatswains, quartermasters, ensigns and lieutenants in Uncle Sam's sea-fighting ranks.

These, then, are the unusual conditions under which Massachusetts essayed to increase its fish landings. That it did not fall far short of an average year is to be wondered at. That it actually was able to show an increase is truly remarkable.

## Figures of the Catch.

The total figures for the year of the fish landings at Gloucester were, in spite of all handicaps made necessary by the war, but little less than the total for 1916, while the landings at Boston for the year were also, under similar war conditions, but little behind the previous year.

### *Gloucester.*

The following statistical bulletin shows the fish landings at the port of Gloucester for the year ending Dec. 31, 1917: —

*Gloucester Total Catch.*

| | 1917. | 1916. |
|---|---|---|
| | Pounds. | Pounds. |
| Salt cod, | 6,439,642 | 7,856,606 |
| Fresh cod, | 20,666,852 | 13,946,630 |
| Halibut, | 875,977 | 1,799,964 |
| Haddock, | 2,790,801 | 6,715,216 |
| Hake, | 863,758 | 2,976,489 |
| Cusk, | 597,756 | 1,589,252 |
| Pollock, | 9,095,363 | 10,424,632 |
| Flitches, | 41,002 | 89,702 |
| Not products of American fisheries, | 32,209,601 | 28,353,748 |
| | 73,580,752 | 73,752,239 |
| | Barrels. | Barrels. |
| Fresh mackerel, | 10,713 | 6,621 |
| Salt mackerel, | 24,349 | 25,503 |
| | Barrels. | Pounds. |
| Fresh herring, | 50,229 | 4,090,350 |
| | Barrels. | Barrels. |
| Salt herring, | 41,268 | 38,897 |
| | Pounds. | Pounds. |
| Frozen herring, | 487,946 | 2,816,680 |
| | Quintals. | Quintals. |
| Cured fish, | 43,569 | 63,560 |

*Miscellaneous.*

| | Pounds. |
|---|---|
| Small boats, | 8,250,000 |
| By rail, | 13,260,000 |
| Flounders, | 480,000 |
| Total, 1917, | 131,026,356 |
| Total, 1916, | 132,252,572 |

## *Boston.*

The year has been a profitable one to those engaged in the fishing industry, although cost of supplies, etc., has increased from 50 to 300 per cent. The yield of the various fisheries were, as a rule, light. The strike in the spring of the year, the taking over of steam trawlers for war purposes, and bad weather in the fall of the year were factors in reducing the

supply. These trawlers would ordinarily land about 25,000,000 pounds of fish in a year. The catch of all kinds of fish on Cape Cod, except whiting, herring and squid, was very light.

The receipts of fish at Boston direct from the fishing fleet, compared with the year 1916, were as follows: —

| | Pounds. | |
|---|---|---|
| | 1917. | 1916. |
| Codfish, large, | 11,267,024 | 7,649,811 |
| Codfish, markets, | 11,513,385 | 9,599,973 |
| Codfish, scrod, | 1,758,978 | 1,071,917 |
| Haddock, | 34,090,015 | 34,351,565 |
| Haddock, scrod, | 11,440,323 | 14,199,920 |
| Hake, | 1,390,405 | 2,233,257 |
| Hake, small, | 3,434,336 | 5,420,587 |
| Pollock, | 4,057,119 | 3,792,169 |
| Cusk, | 2,033,750 | 3,657,429 |
| Halibut, | 490,514 | 1,141,955 |
| Mackerel, large, | 5,839,801 | 5,191,392 |
| Mackerel, medium, | 2,572,192 | 2,341,095 |
| Mackerel, small, | 933,099 | 891,095 |
| Swordfish, | 1,959,771 | 1,773,452 |
| Tilefish, | 1,176,650 | 873,142 |
| Miscellaneous, | 3,226,070 | 4,065,879 |
| Totals, | 97,183,432 | 98,254,638 |

## The Views of a Leading Fish Dealer.

The Board is privileged to quote, in connection with this report, from a letter from Thomas J. Carroll, general manager of the Gorton Pew Fisheries Company, in relation to the effect of the present world war upon the fisheries.

Mr. Carroll writes: —

In reply to your request for my opinion as to the effect of the war on the fisheries, would say that I have given the matter some thought, with the following result: —

Practically all branches of the fisheries have been stimulated by the war, but in no branch has this been more in evidence than in the mackerel fisheries. On account of the falling off in importations of Irish and Nor-

wegian mackerel, the demand for salt mackerel has been greatly increased, and the price is exceedingly higher. This year small salt mackerel are selling at more than double what the same quantity would sell for previous to the war, and this is due entirely to the fact that there are no small mackerel coming from foreign countries.

The herring business has also been benefited on account of the falling off in importations from Holland, Norway and Scotland. The demand for American-packed goods has been great, and the price extremely high, with the result that the fishermen are getting much higher prices for their catches than ever before in the history of the business.

The codfish business has been benefited by the inability of the Norwegian packers of codfish to ship their product to Cuba and South America; also on account of the fact of the great demand for codfish in Italy and Greece, which has given the Newfoundland shippers a market for their product, and taken it out of competition with our goods.

Another part of the business which has been greatly benefited by the war is the canning. The American packers are successfully putting up goods for the American market, which was formerly supplied by foreign packers. Many articles are being put in cans now that were never considered before by the American canner, as he was unable to meet the foreign competition; and in addition to that the consumer called for the foreign article. The American packer has so successfully packed competing goods that the consumer now accepts them, and is perfectly satisfied; so much so, that we all believe that we have a business that will last even when the war is over, and conditions are again normal.

## Résumé of the Doings of the Fleet.

A brief résumé of the activities of the fishing fleet for the year shows that the codfishing and mackerel fleets fared exceedingly well, as did the fall and winter fresh fishing fleets, with haddock as a staple. With the codfishermen it was what is known as a "Quero" year, because on Quero bank the vessels were able to fish uninterruptedly from spring to fall, and so plentiful were the fish that all the fleet were able to make an unusually large number of trips, most of which were limited in size only by the capacity of the vessels. The early months of 1917 found the haddock fleet bringing to Boston many and large fares for which high prices were paid, and again this fall, when haddocking was recommenced by the large fleet, even larger catches and higher prices were the rule. The catches of some of the steam otter trawlers were almost beyond belief. Fishing "to the eastward" on the banks off Nova

Scotia they brought home many fares of from 150,000 to 250,-000 pounds, and almost unbelievable stocks were made on them so great was the demand for fish and so high the prices offered. Several stocks of from $8,000 to $12,000 were made by these crafts.

*One Craft stocked $85,000.*

The banner stock of the whole year is credited to the Provincetown haddocker "Josephine DeCosta," Capt. Manuel Santos, which landed her fish at Boston. The stock claimed for this vessel reaches the magnificent total of $85,000, a mark never before attained in the history of the fisheries of the State, — by a sailing vessel at least. The crew's share was $2,200 per man.

*Remarkable Mackerel Stock.*

What is probably the most remarkable stock ever made in the Massachusetts fisheries, however, is that of schooner "Mary F. Curtis," Capt. Lemuel E. Firth, one of the Gloucester mackerel seining fleet, which in just six months rolled up the great total stock of $82,509.21, and on which the members of the crew each shared $1,898.04 "clear," — that is, clear of their share of the expenses and their living aboard.

The craft sailed on her first trip south April 26, and thus her season was just six months to a day. Her stock is indisputably the greatest ever made at mackerel seining, and in well-informed fishing circles it is also hailed as the largest stock ever made in actual fishing by any fishing vessel in any line of fishing in the same length of time.

The record is one over which Captain Firth and his men have every reason to feel proud, and it will be some time to come, it is believed, before the feat is duplicated, if ever.

For years Captain Firth has been one of the leading skippers of Gloucester, and at the end of each seining season has been up among the leaders. This season he started at a record-breaking pace, which he has kept up to the very end. Captain Firth is a skipper of unusual energy, practically tireless, and has surrounded himself with a splendid crew of hard workers. He is also possessed of an extra amount of good judgment,

has been a close student of the habits and movements of mackerel schools, and his reward is seen in the great world's record he has just achieved.

*The Season's Mackerel Catch.*

The season's total mackerel catch is 144,094 barrels, of which 32,162 barrels are salt and 111,932 barrels fresh. In 1916 the catch was 134,296 barrels, of which 32,066 barrels were salt and 102,230 barrels fresh. The salt catch for the two seasons, it will be seen, is about the same.

*"Good Old Days" surpassed.*

Congratulations should be extended to all engaged in the mackerel fishery of 1917 for producing the best catch in recent years. Prices received for the fish, whether landed fresh or salt, were such that it is figured no mackerel fishing season, not even in the "good old days," when fish were so plentiful that the catch was two and three times as large, ever produced such a large financial return to the fleet.

The mackerel fleet was late in getting away in the spring, owing to the fishermen's strike, and the season out south was partly over when the matter was adjudicated and the crafts sailed. This was offset, however, by an unusually prosperous season on the "Cape Shore," as the Nova Scotia coast is called, in late May and early June, followed by a most prosperous summer on the Massachusetts coast in South Channel, on Nantucket Shoals and in the vicinity of Marthas Vineyard and No Man's Land.

The fresh halibut fishery was followed by a smaller fleet than in 1916, and the catch materially reduced, but most unusual financial returns were realized on account of prices well sustained throughout the whole season, even in the summer months.

The various shore fisheries, pursued in season by the large fleet of gill netters and the large number of Italian gasolene powered craft, were also successful to a degree probably never equaled.

Altogether the fishing year of 1917 can be said to be one of the most prosperous on record for all engaged, whether fisherman, master mariner, vessel owner, fish dealer or shipper.

### THE FISHERMEN'S STRIKE.

One of the most significant events of the fishing year was the strike of the Fishermen's Union of the Atlantic at Boston and Gloucester. As the union included in its membership nearly all of the fishermen at these ports, the tie-up was practically complete. The strike began on March 1 and continued for nearly eight weeks, an agreement between the union and the vessel owners being arrived at on April 20 "for the duration of the war," after Governor McCall had taken a hand in the matter, designating a subcommittee from the Committee on Public Safety to confer with both sides and urge upon them the seriousness of the situation.

Attempts of both interested parties to get together had failed, and offers of its good offices by the State Board of Conciliation and Arbitration to bring about an agreement were not accepted.

The committee (comprising Henry B. Endicott, Charles S. Baxter, John F. Stevens and J. Frank O'Hare) held its conferences with both sides at Gloucester, and the agreement, outside of a few minor points which were quickly agreed upon, was reached at 2 P.M. April 20, as follows: —

FIRST. — The masters and owners hereby accept and agree to carry out Resolutions Nos. 1, 2, 3, 4, 5 and 6 of the resolutions submitted to them by the Fishermen's Union.

SECOND. — As to Resolution No. 7 it is mutually agreed as follows: —

*Hoisting Engines.* — Whenever hoisting engines are used there shall be a charge made therefor, but the crews may decide that no use of such engines shall be made.

*Propelling Engines.* — All vessels now having engines, and charging therefor, may continue to make such charge as heretofore. All vessels now having engines not making such charge shall not hereafter begin such charge. On any vessel hereafter installing an engine the lay shall be adjusted between the captain and the crew.

THIRD. — As to Resolution No. 8, it is mutually agreed as follows: —

The captain or owner will furnish the gear and collect 10 per cent. of the share of each member of the crew on each trip until the original cost of the gear is paid, then the gear shall be "free gear," so called. No charge is to be made for the use of the gear. Lost and condemned gear, and the general upkeep of the gear, shall be paid for out of the gross stock.

This settlement between the owners and masters and members of the

crews shall continue for the period of the present war, and shall not be modified except by agreement of all parties.

Owners and captains will not discriminate between union and non-union men in shipping their crews, or in the employment of members of unions that struck in sympathy with the Fishermen's Union.

### Demand for Fish greatly increased.

As illustrative of the greatly increased demand for salt fish it need only be cited that the landings of salt fish this year at the port of Gloucester from Canadian, Labrador and Newfoundland waters will be in the neighborhood of 40,000,000 pounds. This large amount is brought to the fishing ports in American as well as Canadian and Newfoundland vessels.

While strictly speaking, perhaps, considerable of this is foreign fish, still, in a measure much of it is half American. The large Massachusetts firms have fishing stations all along the treaty coast of Newfoundland and Labrador, where the United States has "in common" treaty rights, so that fish from these localities can properly be classed as product of the American fisheries; also large concerns have fishing stations dotting all along the non-treaty coasts of Canada and Newfoundland, where buyers and working crews representing the firms spend the summer and fall months buying and attending to the curing of the trips of boats and larger vessels brought in from time to time. The fish are paid for in the American way of doing business, by quick cash settlement, which is highly pleasing to the fishermen of the Canadian and Newfoundland coasts.

### A Record for One Day's Fish Receipts.

One of the notable occurrences of the fish year was the arrival at the port of Gloucester of 5,000,000 pounds of fish in one day. This was on Aug. 20, 1917, when some 35 vessels arrived in the harbor to take out their fares. The fish were mostly salt cod, but there were some fares of fresh and salt mackerel. The range of the trips was from the large crafts, bringing trips of from 300,000 to 462,000 pounds of salt codfish, down to the shore boats with small fares of fresh or salt mackerel. This, as far as all available records go, is the

largest amount of fish to arrive at an Atlantic fishing port in one day, and the same statement is believed to apply to any American fishing port.

## The Lobster Fishery.

It would be chanting the old refrain to say that the lobster industry is on the decline. For too long a time all those States interested in the fishery, either past or present, have been contented to accept this as a fact, while making little effort of a constructive nature to either hold the present conditions or to improve them.

Various conferences have been held throughout the country in relation to the lobster industry, and certain general propositions have been agreed upon, as, for instance, the necessity of having a uniform length of lobster and a uniform plan upon which restoration will be worked out. All parties in interest seem agreed that the ideal plan would be to take lobsters only of a given size, thus giving the short ones an opportunity to mature, while at the same time preserving the very large ones as a brood stock. But the great practical difficulty seems to be in agreeing on what shall be the marketable size of lobsters. The dealers in Massachusetts, for example, represent that the public demand a lobster of about the 9-inch length, and that to make the minimum size 10 to 10½ inches would be working a great hardship on the public, and would seriously cut into the business. Most of the other States have adopted as the legal measure 4⅛ inches on the back (carapace), which is equivalent to an uncooked lobster at 9 inches or a cooked one of 8¾ inches, while Maine has a limit of 8¾ inches carapace measure, equivalent to a 10½-inch lobster. The Provinces to the north are more or less indifferent, taking anything they can catch.

Unquestionably the chief causes of the decline in the fishery are overfishing and the neglect of suitable artificial propagation and effective closed seasons. It appears that artificial propagation has advanced to the point where it can be profitably resorted to. The Commissioners are so impressed with this fact that in maturing plans for a large salt-water fish hatchery, which we hope some day to have built on the shores

of Massachusetts, a very substantial unit of it is to be devoted to this work. Moreover, your Commissioners believe that some concerted action must be adopted by the several States and countries within whose territorial waters lie most of the spawning grounds to adopt some measures by which the shorts and the adult breeders can be protected.

The enforcement of laws will not be of any lasting benefit unless those laws are more or less uniform throughout the range, varied, of course, to suit local conditions, but always directed to adequately protecting the lobster; for example, when the lobsters are received by the Boston dealers, all the shipments are carefully inspected by the deputies of this department. All short lobsters are collected and are planted alive in the coastal waters of Massachusetts. Last year over 37,000 shorts and over 200 seed lobsters were seized. These lobsters were systematically planted from Cape Ann to Provincetown. Also, 1,300 egg-bearing lobsters were purchased and liberated in our waters. These were lobsters which the dealers had bought and paid for in shipments from outside the State, which arrived at the egg-bearing stage while in storage cars and unless purchased by the department would in many cases have been destroyed. It may be argued that Massachusetts benefited substantially by these operations and, on the other hand, it represented an economic loss in the localities where these shorts and seeders were taken. It is not the wish of Massachusetts to profit by the misfortune of her neighbors and the above fact is related to give weight to the claim that uniform laws must be adopted and enforced.

By this statement we have no intention of indicting the lobster dealers of Boston as being a party to the illegal transactions. The Commissioners believe that in the majority of cases they are the victims of the shippers in the Provinces, who, by including a certain number of shorts in their shipments, literally try to force the Boston dealers to accept them and dispose of them somehow.

During the past year practically nothing has been done by this Board in relation to the lobster industry except to rigidly enforce the law in respect to short lobsters, especially as relates to outside shipments. There is no question but that a

certain amount of illegal traffic in short lobsters is still taking place on our shores. This, as all other problems in law enforcement, involves the element of education. The public is being given more fully to understand how penny-wise and pound-foolish is the attitude of the man, who, engaged in the industry or possibly living on the shores as a summer resident, wishes to maintain and increase the fishery, and yet wittingly or unwittingly is killing it by not giving the lobsters a chance.

During the past three years the fishermen in all branches of the fisheries have formed associations for their own protection, and to-day a large part of the lobstermen are organized. These associations have proven of benefit both to the members and to the industry. The men are closer allied with one another, and matters of common interest are acted upon by them as a body. Every member who lives up to the rules (as most of them apparently do) is made to feel that he has a distinct part in restoring the fishery. The co-operation which the deputies have received from members of these associations has made it possible for the force to keep a much closer line on the situation.

As a further evidence of the value of these associations it may be mentioned that, largely through their agency, the last Legislature enacted the lobster license bill (chapter 312, General Acts of 1917), requiring every lobster fisherman to take out a license at a cost of $1. A person twice convicted of violation of any of the lobster laws loses his license for one year. This law cannot fail to be of benefit to the fishery.

### Shad.

As indicated in the last annual report this Board, in conjunction with the Fish and Game Commissions of California and Connecticut, has erected a station for taking shad eggs on the Feather River, a tributary of the Sacramento River in California. Hopes of receiving a shipment of shad eggs in the spring ran high, but circumstances were such as to prevent it, as set forth in the following letter of May 4, 1917, from the California Fish and Game Commission: —

Your letter of April 21 received. We regret that we are not in a position, this season, to collect shad eggs. Owing to the rush of work on

other lines, and the passing of a law by the Legislature that has just adjourned that we hope will protect the shad next season, so that the spawning shad can reach the spawning grounds, we have decided not to do any shad work this year.

Last season the market fishermen caught so many shad on the bays and lower reaches of the river that the schools were scattered to such an extent that it was difficult to get enough fish at one time or place to justify the expense. At this session of the Legislature a bill was passed making a closed season on shad from June 6 to August 1. We hope that this will give the spawning fish a chance. Our plans are to wait for this season before beginning operations on shad work in this State. Under the laws of this State, an act passed by the Legislature does not go into effect until ninety days after the adjournment of the Legislature. The Legislature has just adjourned, so the law will not go into effect until June, 1918. We intend to get ready in the meantime to carry on the operations this coming season. We do not deem it advisable to open a shad hatchery until the new law goes into effect. We will be pleased to furnish you the eggs when we are properly equipped for egg collecting, next season.

Enclosed find photo of shad egg collecting station operated by California Fish and Game Commission at Yuba City, Cal.

We are disappointed in not being able to do some shad work this season, but after studying the conditions we feel that we will be in a better position to operate next season, when the spawning fish will be protected and we will be fully equipped to do the work right.

Connecticut has wisely repealed some of its laws relative to the seining of fish in the tributaries of the Connecticut River, and it is believed that this action will have far-reaching effects, inasmuch as it will permit more fish to reach the spawning grounds at South Hadley Falls.

Efforts of this Commission will be continued. It would be an odd commentary on things if Massachusetts, which gave the shad to California, should be assisted by California in bringing back what is now almost an extinct fishery.

## ACTIVITIES IN CONNECTION WITH NATIONAL FOOD REGULATION AND CONSERVATION.

### Fish Men at National Food Administration Conference.

On Sept. 24 and 25, 1917, there took place a conference of the leading fish producers and shippers of the country and officials of the National Food Administration at Washington, D. C., the session being called for the purpose of thoroughly learning the present condition of the industry, and, in the face of war conditions, to consider plans and methods for increasing production and suggest how better and more expeditious transportation of fish shipments might be attained.

The two days' convention was attended by 68 of the country's notable fish men, all the way from the Pacific coast, the Great Lakes, Gulf of Mexico ports, places along the Mississippi River and the Atlantic seaboard. The importance of such a gathering was early sensed by His Excellency Governor McCall, who delegated one of the members of the Fish and Game Commission to attend as official representative of the State of Massachusetts. The conference met at the Food Administration building, being presided over by Mr. Kenneth Fowler of New York, chief of the fish division of the Food Administration, who, in opening, called attention to the critical condition of the country's food supply, and the necessity of "speeding up" the fisheries, in order that the greatly needed increased supply might be secured. In the course of its sessions the members were honored by a personal visit of Food Administrator Hoover, who delivered such a straightforward talk as left its impression on every man present in the form of a firm determination to do all possible to increase the fish supply of the nation.

For two days those in attendance went carefully over every phase of the fisheries question, and it was decided without dissension that the greatest factors standing in the way of largely increasing the catch of fish were the numerous State laws covering, limiting or prohibiting the catching of fish in waters under State jurisdiction, and that these laws should be suspended or modified for the duration of the war.

On September 26, following the two days of general discussion and testimony, which closed harmoniously with the slogan of "Catch 'em for Uncle Sam," a conference was held in the Food Administration office on the subject of State laws restricting fishing operations at various points on the Atlantic coast, at which the following named persons were present: Dr. Hugh M. Smith, United States Commissioner of Fisheries; Mr. Arthur L. Millett of the Massachusetts Fish and Game Commission, delegate officially representing the State of Massachusetts; Mr. Gardner Poole, representing the fish industry at Boston; and Mr. Kenneth Fowler, representing the Food Administration.

Reporting on this conference, Commissioner Millett says Mr. Fowler, on behalf of the Food Administration, stated: —

Within the last three weeks we have had very emphatic complaints and appeals from various producing sections along the Atlantic coast that all restrictions on the free operation of the salt-water fisheries be entirely removed for the duration of the war. Summarized, these appeals are as follows: —

From various points in North Carolina, including particularly Beaufort and Moorehead City, appeals and petitions by a great many fishermen and producers, telegrams from various sources in the North Carolina district, including wires from the Beaufort, N. C., Chamber of Commerce, and a special petition from that Chamber of Commerce. The situation particularly emphasized in North Carolina is in the nature of a request that the State law restricting all purse-seining operations within the 3-mile limit be entirely removed. The Chamber of Commerce of Beaufort is on record as saying that, since the purse-seining laws have been in effect, the catch of food fish in this district has fallen off 90 per cent., and that unless immediate action is taken the fishing industry will be entirely destroyed. The petition from this Chamber of Commerce cites the following: —

Prior to the enactment of the law aginst purse seining the shipment from Beaufort of salt fish (mullet) amounted to much more than a million pounds per season, that is, from August to December 1, while the shipment of fresh fish, under ice, during the same time was in excess of 3,000,000 pounds. The shipment of these fish was in solid car lots, and at times in solid steamer lots, to the markets north and the State markets. Since the purse-seining laws have been in force the shipment of salt fish during the same season has now dwindled down to approximately 150,000 pounds, and many of the largest fish packers in the business have closed their business on account of not being able to get fish for their trade. The appeals from Moorehead City and other points in North Carolina are equally emphatic.

The situation in the State of New Jersey is emphasized by many letters and petitions from fish producers at various points along the Jersey coast, calling particular attention to the operation of the law against purse seining within the 3-mile limit on the coast of that State. Letters and appeals from Atlantic City cite a number of instances within the last few weeks where purse-seining vessels have actually had their seines around large bodies of food fish, principally weak fish, and were called upon by the game wardens patrolling the coast to liberate their catches. A message from one producer is as follows: —

Our boat caught about 200 barrels of weak fish, and the game warden made us let them go, as we caught them inside the 3-mile limit. This catch of weak fish weighed about 40,000 pounds, and, as I know you are interested in the food problem of the country, and as we would have sold these fish for 2½ cents per pound, that would greatly help a lot of poor people who must pay 30 cents per pound for meat. In addition to our boat, another boat was compelled to turn out 20,000 pounds of fish of the same kind, and I think you will agree with us that it was a sin and a shame to practically waste that food under present conditions. There are about 15 such boats as ours fishing with purse nets from Atlantic City alone. These boats take a crew of 10 men each, all from local neighborhoods, and do you not think there could be some way or means that we might be allowed to catch such fish when we have the opportunity?

Many similar letters in our files can be cited to emphasize these conditions further.

Data in possession of the Food Administration as regards the stand taken by the British Isles in connection with the salt-water fisheries and war measures are as follows: —

By a very recent order the Food Controller of Great Britain has wiped out all restrictions of any nature or description on salt-water fishing in any of the territorial waters of Ireland, and we are advised the same action has been taken as regards all the waters of Great Britain. This action by the Food Controller, briefly quoted, is as follows: —

"In exercise of powers conferred upon him by the Defense of the Realm Regulations, and also of all other powers enabling him in that behalf, the Food Controller hereby orders as follows: —

" (1) The Department of Agriculture and Technical Instruction for Ireland may by order authorize (*a*) the use in tidal or territorial waters, for the purpose of taking sea fish, of any method or appliance the use of which would otherwise be unlawful; (*b*) the use in territorial or tidal waters, for the purpose of the aforesaid, of any method or appliance at times and places in circumstances at and in which the use of such methods or appliances would otherwise be unlawful; and (*c*) the fishing for or removal of fish in tidal or territorial waters, or the possession, sale, exposure or consignment for sale or purchase of any sea fish at time otherwise unlawful."

At the conference of representatives of the fish industry from the different sections of the United States, held September 24 and 25 at Washington, D. C., at the request of the Food Administration, the reports rendered from producing districts in the different parts of the country

clearly indicate that, with the exception of the fisheries for ground fish, such as cod, haddock, etc., in the New England district, the present production of salt-water fish, and particularly the pelagic or migratory varieties, is from 25 to 50 per cent. below the normal average; also that the catch of the fresh-water fish is considerably below normal. That is further emphasized by reports from the Pacific coast, which show a relatively short production of halibut and an extremely short production of the various varieties of salmon, especially as regards these varieties entering into consumption as fresh frozen salmon.

### *Resolutions adopted by Fish Men.*

At the conference above referred to the following resolution was offered by Mr. George T. Moon of New York City, and was unanimously adopted: —

> To sum up the question of State laws, it seems to me, from expressions made by gentlemen representing every section, that this should be in our minds, — that our opportunities for speeding production are restricted by the various State laws now on the statute books with reference to fish and game. It would therefore seem to be in order for this conference to place itself on record that it is the sense of this conference that the Food Commission investigate and inquire into the various State laws covering the catching of fish, and do their best, by action in the various State Legislatures, to have these laws suspended or so modified during the present war as to bring about the results we desire, always keeping in mind the conservation of the supplies in the various States. I would like to have that put on record as being the wish of this convention, if the gentlemen agree with me and think it is proper.

### *Deductions and Recommendations.*

Under all the circumstances, the Food Administration believes that every effort should be made, as a war measure, to speed up the salt-water fisheries on both coasts, and that in this campaign of speeding up it is highly essential, and, in fact, vital, that in so far as possible the restrictions embodied in these State laws be removed for the duration of the war. To this end the following specific resolutions were adopted. We would particularly recommend the removal of all restrictions on the purse-seining operations within the 3-mile limit on the shores of all the Atlantic coast States where restrictive laws are now in force, and we are prepared to recommend that torching restrictions, wherever present, be fully removed.

We strongly advise prompt action in each State, predicated on the foregoing facts, and that everything standing in the way

of quick and complete results be suspended during the period of the war. The laws of some of the States already give sufficient power to the fish and game commissions to act in the premises, and in the remaining States, where this power does not rest with the executive, a special enabling act may be necessary.

We have requested Mr. Millett to deliver to Governor McCall a special message from the Food Administration, outlining the recommendations heretofore set forth, and suggest that prompt action by the Executive of the greatest fish State of the Atlantic coast will act as a most emphatic message to the Executives of the other Atlantic coast States.

Supplementing the above, Dr. Hugh M. Smith stated: —

I would like to say that, in view of the urgency of the food situation and the necessity of producing the largest possible quantity of food fish, the commissioner is of the opinion that local laws restricting commercial fishing operations could very properly be suspended for the duration of the war without fear of any permanent effect on the supply.

Commissioner Millett said: —

I coincide and concur in every particular with the statement of Dr. Smith, and I also am absolutely in favor of the recommendations made by Mr. Fowler. I believe that the urgency of the situation demands any sacrifice at the present time, and I also believe that the sacrifice will not be too great.

### The Fish and Game Commission Concurs.

On the morning of September 27 the Board of Commissioners on Fisheries and Game convened, at which time the member returning from the conference made a verbal report of the Washington meetings. The report as presented received the unanimous approval of the full Board, and steps were immediately taken to put the recommendations into practical operation.

### The Governor's Proclamation.

Later in the day the following proclamation was issued by Governor McCall, requesting all local authorities having jurisdiction over salt-water fisheries, in the interest of national food regulation and conservation, in so far as practicable, to carry

out the suggestions contained in the following statement by him: —

On recommendation of Mr. Henry B. Endicott, Food Commissioner for Massachusetts, Mr. Herbert C. Hoover, Federal Food Administrator, Dr. Hugh M. Smith, United States Commissioner of Fisheries, and the Massachusetts Fish and Game Commission, it seems essential, in view of the existing food shortage, that no unnecessary restrictions be imposed on fishing for herring either for use as bait or food. It is not desirable, however, that any restrictions should be removed so as to permit any additional use of these fish for oil or fertilizer, or any other purpose except bait or food.

There are numerous laws of the Commonwealth forbidding any person to fish for herring by torches, and in certain instances by seines, in local waters which are designated in these laws. In most cases the local city or town authorities are authorized to grant permits to fish by these means in the waters under their jurisdiction. I respectfully urge upon these local authorities the necessity, during the present emergency, of granting such permits liberally, both to the inhabitants of their own towns and to outsiders, so far as necessary to assure a full catch of fish.

## Report to the Governor.

The following report of the two-day meeting at the Food Administration at Washington, D. C., and the conference which followed was made to Governor McCall by the member of the Board who attended as official delegate representing the State: —

Sept. 27, 1917.

To His Excellency Governor McCall, *State House, Boston, Mass.*

Dear Sir: — Having returned from Washington, where I went by your appointment to attend the national conference of fish producers and shippers, called by and held at the request of the National Food Administration, of which Mr. Hoover is director, I feel that a brief report of the sessions which were held on September 24, 25 and 26 may be proper as a matter of record, the event being unprecedented in the history of the fishing interests of the country.

On assembling, the gathering, consisting of 68 representatives of the great fishing concerns of the country, all the way from Seattle, St. Louis, Kansas City, Chicago, Erie, Portland, Gloucester, Provincetown, Boston, New York, Philadelphia, Baltimore, Washington, Norfolk, Galveston, Savannah, Miami, Pensacola, Chincoteague, Palm Beach, Punta Gorda, and other places, was met by Mr. Kenneth Fowler, in charge of the fisheries division of the Food Administration work, who addressed it

briefly on the purposes of the meeting, which were to consider the present condition of the business with regard to supply as compared with normal years, how best to "speed up" and increase the supply, and to improve and facilitate transportation so as to reach the largest possible number of the peoples of the country.

Under these various heads the fish men from each of the above sections were heard in turn, and the session was most orderly in character and serious in tone. Both Gloucester and Boston, as befitted this the greatest fishing State of the Nation, sent large and very representative delegations, the members of which took a very prominent part in the proceedings. It seems to me to be a matter for congratulation that, in spite of the drains made by the service call of the Nation in commandeering many of our largest fish crafts for naval uses, and also the taking of many of our master mariners and fishermen into the navy and Naval Reserve, Massachusetts was the only section of the country able to report an increase in catch over last year, to date, in nearly every branch of her fisheries. One most important fact brought out, however, was the present lack of bait supply for our large fishing fleet operations this coming winter, when most extensive fishing will be done, when fresh bait is an impossibility and the freezer supply must be depended on and therefore should be most ample.

The Massachusetts men also expressed themselves in the most patriotic strain, as being ready and willing to do everything in their power to assist the Food Administration in its plan to "speed up" and increase the fish output of the country by 50 per cent. A big contract truly, but these men were told that it must be done; that the conditions demanded it.

The Boston delegation comprised Messrs. Gardner Poole, William K. Beardsley, John Burns, William Rich, Fred M. Kimball and A. L. Parker.

The Gloucester delegation comprised Messrs. Fred L. Davis, Thomas J. Carroll, Henry F. Brown and Charles Andrews.

Mr. W. I. Atwood attended from Provincetown.

One of the notable events of the conference was the appearance before the members of National Food Director Hoover, and his address to the fish men assembled. It was brisk and businesslike, clear-cut and crisp, sober, serious; even solemn. It brought forcibly to the minds of the men present the actual food conditions confronting the United States and her Allies, the extra burden which the former must bear for the latter on the food end in order to "win the war," and left no doubt in their minds that their patriotic duty was to increase the fish supply. The address teemed with cold, hard facts, deliberate expressions of responsibility, and left nothing to imagination. It had its effect.

Besides Mr. Hoover, the conference had the pleasure of listening to addresses, all along serious lines, by Mr. Hoover's chief assistant, Dr. Hugh M. Smith, United States Commissioner of Fisheries, and Dr. Pennington of the Department of Agriculture.

In the discussion what to do to "speed up" and increase the fish supply, the story from every section of the country was the same, — hampered by restrictive State legislation, — and it was the sense of the meeting, expressed in a resolution offered by Mr. George T. Moon of New York, that action be taken by the various State Legislatures to have these laws suspended or modified for the duration of the war. For further action on this subject I refer you to the report of the conference following the two days' meeting, which I transmitted to your office on the morning of September 27, and which practically tells what was accomplished as a result of the bringing together of the fish men from all over the country.

In closing I desire to say that both Mr. Hoover and Mr. Fowler expressed their gratification that you so keenly sensed the gravity and seriousness of the situation as to have Massachusetts officially represented at the conference, and it may be pleasing to you to know that your representative was called also to sit in the official conference at the close of the two days' hearing, which mapped out and decided upon a plan of action.

Briefly, this plan, which I have already transmitted to you in full, and which aims to "speed up" and increase the fish supply of the Nation, was to advise prompt action in each State that in so far as possible the restrictions of the various States on the salt-water fisheries be removed for the duration of the war, on the ground that such action is highly essential, and, in fact, vital. Under this head of restrictions to be removed should come the herring torching regulations, so called, in force in this State.

At this official conference your representative was requested to deliver to Your Excellency a special message from the Food Administration, outlining the recommendations set forth in the official report I have already delivered to your office, and also to suggest that prompt action by you, the Executive of the greatest fish State of the Atlantic coast, will act as a most emphatic message to the Executives of the other Atlantic States.

In conclusion may I be permitted to express my appreciation of being able through your appointment to have been officially present at such a notable gathering where such important war-emergency legislation was recommended.

Arthur L. Millett,
*Member, Massachusetts Fish and Game Commission.*

## Board notifies City and Town Officials.

Later the Fish and Game Commission sent the following notice to city and town officials of Massachusetts having jurisdiction over the granting of permits to take herring in the coastal waters at different points along the shore: —

Gentlemen: — The Massachusetts Fish and Game Commission at its meeting this week considered carefully the request of Governor McCall, recently made public, requesting all local authorities having jurisdiction over salt-water fishing laws in the interest of national food regulation and conservation, in so far as practicable, to see to it that no unnecessary restrictions be imposed on the fishing for herring for use as bait or food. The Governor's proclamation is as follows: —

On recommendation of Mr. Henry B. Endicott, Food Commissioner for Massachusetts, Mr. Herbert C. Hoover, Federal Food Administrator, Dr. Hugh M. Smith, United States Commissioner of Fisheries, and the Massachusetts Fish and Game Commission, it seems essential, in view of the existing food shortage, that no unnecessary restrictions be imposed on fishing for herring either for use as bait or food. It is not desirable, however, that any restrictions should be removed so far as to permit any additional use of these fish for oil or fertilizer, or any other purpose except bait or food.

There are numerous laws of the Commonwealth forbidding any person to fish for herring by torches, and in certain instances by seines, in local waters which are designated by these laws. In most cases the local city or town authorities are authorized to grant permits to fish by these means in the waters under their jurisdiction. I respectfully urge upon these local authorities the necessity during the present emergency of granting such permits liberally, both to the inhabitants of their own towns, and to outsiders, so far as necessary to assure a full catch of fish.

In connection with His Excellency's proclamation we take the liberty of quoting the following from an opinion of Dr. Hugh M. Smith, United States Commissioner of Fisheries, given in Washington recently, at a conference of the Food Conservation Commission, relative to the food problems in so far as they relate to making available without delay the largest possible supply of fish both for bait and food. Dr. Smith said: —

I would like to say that, in view of the urgency of the food situation, and the necessity for producing the largest possible quantity of food fish, the commissioner is of the opinion that local laws restricting commercial fishing operations could very properly be suspended for the duration of the war, without fear of any permanent effect on the supply.

On consulting the statutes it appears that the authority lies in the hands of the selectmen of the towns and mayors and boards of aldermen, and in certain instances the boards of health, to grant such permits as may be required to give force and effect to the above proclamation.

In order that some uniform basis of action may be established and the maximum efficiency be given to the movement, we respectfully invite your consideration of the following suggestions, bearing in mind that this Board is fully in accord with His Excellency's proclamation.

1. That such permits as are granted be for a period of three months, with a provision for a renewal for a further period of three months in those cases where the operations of the licensee appear satisfactory to the granting board.

2. That the right of revocation at all times be retained by the granting board.

3. That in said permits it shall be stipulated that no licensee shall use a net of a mesh less than $1\frac{1}{2}$ inches.

4. That the contents of torches shall not be dumped at such time or in such places as to be a menace to shipping or property in general.

5. That no herring shall be dumped or discarded in such a way as to become a menace to public health.

The Board, appreciating the fact that the jurisdiction in this matter rests in your hands, has taken the liberty of calling your attention to the foregoing as a result of its great desire to co-operate with you in removing such restrictions as may delay in getting action. We are alive to the gravity of the situation, and are suggesting the above to you as a war measure. The fish are now off our shore, and delay in action may result in the loss of the whole supply of bait for the winter's fishing, and in addition represent the loss of a tremendous food supply. We urge upon you to take immediate action in the premises.

Very truly yours,

William C. Adams,
George H. Graham,
Arthur L. Millett,
*Commissioners on Fisheries and Game.*

As far as can be ascertained, officials of the various localities, the waters of which are frequented by herring, have responded to the request of the Governor and this Board with a truly patriotic spirit. Once more Massachusetts has gained the honor of being first in a movement of national importance, — in this case one which means much in increasing the food supply of the people of the United States at this critical time. Other States, after learning of the action of Massachusetts, hastened to fall in line in removing or suspending such restrictions as prevented fruition of the Food Administration's plan of "speeding up" the fisheries of the nation.

## THE GRAYFISH HAS COME TO STAY.

It looks as though the grayfish, formerly known as the dogfish, also called "pest" and other names, and cordially hated by every fisherman who ever set a trawl, has come into its own as a food product of flavor and value. It was only a few years ago that there was a general movement in fishing centers seeking to hit upon some plan for the extermination of this fish, which is, at the present time, in such popular favor with the fish-eating public that the demand exceeds the supply.

Numerous plans were proposed, such as the establishment, as has been done in Nova Scotia, of reduction works, where the fish could be turned into fertilizer and oil. Other plans were to pay the fishermen a bounty for evidence of every dogfish caught and put *hors de combat,* and ream after ream of arguments and innumerable tables of figures were produced to show in dollars the extent of the damage done the fishing fleet by the depredations of this fish. It remained for the National Bureau of Fisheries to solve the question, which it did in a most sensible and natural way, when one comes to think of it in the proper light. For some time the Bureau experts had declared that the dogfish was highly edible and nutritious and of good flavor, but that old name "dogfish" just could not be got over in the public mind. Dogfish for food as "dogfish" was simply impossible.

Then came the solution. Why not change the name? Sure enough, why not? And it was done, and "grayfish" came into official being. Its success was assured from the start. A grayfish dinner attended by notables was actually held in Washington. Secretary Redfield of the Department of Commerce became a sponsor for the much maligned fish, and ladies of the Cabinet circle took so much interest in launching this new fish food that they furnished the Bureau of Fisheries with numerous recipes for serving it.

The Bureau at once launched an extensive publicity campaign, and the recipes were sent broadcast throughout the country, so that grayfish soon became well known. It could not very well be said that grayfish was in everybody's mouth, because there was not enough to go around.

This publicity campaign was begun in 1916, and that same year the Gorton-Pew Fisheries Company of Gloucester, realizing the value of the fish as a food product, entered upon the work of securing trips of grayfish and canning the fish. This venture met with such success that the total pack was sold long before winter was over.

This year the company continued the canning of grayfish, taking in the fish caught by the boats right along the shore and landed almost alive every day; and, despite the fact that every available boat and fisherman was secured, and the landings far in excess of the previous season, it was the same story as far as supply and demand was concerned, for the latter was overwhelming, and the former not sufficient to meet the calls for "more."

In addition to this, the vessels of the tilefishing fleet, which make their market in New York at Fulton Market, saved some of the dogfish which they caught on their trawls, and which abound in the region where they fish, about 100 miles off New York, and these have found a ready and increasing market at that place. Indeed, there are those who have observed closely, who claim that in time the demand for fresh dogfish in New York will outgrow the supply.

Be that as it may, the fact remains that grayfish as an article of fish food is now firmly fixed in public favor, and that an increased supply will be needed next year to supply the demand. Of course, the chief call for the fish at present is in the canned state. In this way it certainly hands a hard knock to the high cost of living, for in spite of the increase in almost every article of food since the war began, this fish is put up in pound cans and marketed by the producers so that they can be sold by the retailer at "two cans for a quarter," — really a cheap article of food when one stops to think of it.

In January, 1917, the Fish and Game Commission reported to the Legislature, in obedience to an order from that body to investigate and report on the necessity and expediency of adopting measures for the destruction of the dogfish in the waters of the State, that it was inexpedient to attempt the destruction of the fish. The Board at that time was in accord with the plan of the National Bureau of Fisheries to exploit the fish as a worthy fish product, and, in the face of facts

brought out by a two-season trial of the idea, sees no reason for changing its mind. Indeed, the Board feels that the grayfish is destined to fill a very large niche in the food supply market as a nutritious and cheap fish food product; for example, during the season of 1916 the Massachusetts landings of grayfish aggregated a little over 200,000 pounds. For the present season, 1917, the landings up to the latter part of October were over a million and a half pounds, and practically the whole of this, representing 20,000 cases, with 48 1-pound cans to a case, is already (in November) sold out of first hands. Surely the grayfish has come to stay. The marked increase in sales over the first year of the venture shows that the aversion of the public for a too suggestive or repulsive name can be overcome by the combination of changing the cognomen and showing that the fish is "really good to eat." In other words, there is now no such fish as the "dogfish," and the public has come to know "grayfish" as a clean, wholesome, nutritious, well-flavored and cheap article of fish diet.

It may be of interest to know how and where the grayfish are caught, and how they are handled from the time the Italian fishermen haul them from the water and slat them off their trawls into the boat until they start off for the train or boat, canned, labeled and boxed, and all ready to be opened and served on the table in full twenty or more different ways, as the fancy of the housewife dictates.

Let us go down to the wharf in Gloucester — an early morning stroll to greet the rising sun — to one of the piers where the great fleet of Italian boats makes headquarters. Here the scene is one of great animation. Down the pier come some of the fishermen bringing their trawls with them, all baited, while others are already on board baiting up. You must not expect to understand what they say, for they are speaking their native Italian, and all seem to be talking at once; but should you speak to almost any one of them your reply would almost invariably come in very good English.

Gradually the crafts get away in one's and two's and three's, and the chugging of their motors falls sharp on the still air. These Italian fishing boats are decked-over crafts of the most staunch design, and all of them are fitted with gasoline engines of much power. Your Italian is proud of his craft, and keeps

her in the best of shape; indeed, as the fleet gets away it is somewhat like a glimpse of old Italy, for each blunt, high-out-of-water craft is resplendent in a paint dress of brilliant blues and reds and yellows, in sharp contrast to the prim, black, silky-looking sides of the sharp speed vessels of the "Yankee" fleet.

Out beyond the western point the crafts go. The fishing is done from June or July to October, or while the fish are on the near-by coast, the fishing grounds extending from the lightship in Boston Bay out to Stellwagen Bank and off Thatcher's Island, and also around in Ipswich Bay.

Once on the fishing ground no time is lost by the from three to five men that each craft carries, and soon the six or seven tubs of trawl of each boat — they range in size from a little under 5 tons to up to 15 — are in the water and fishing. Each of these tubs of trawl consists of 9 or 10 lines of 50 fathoms' length each, thus giving each boat a fishing radius of fully 4 miles. The hooks being set about 6 feet apart present 3,500 baited hooks for the inspection and acceptance of Mr. Grayfish.

After hauling the trawls and tossing the catch into the hold the boats head for the home port, generally arriving all the way from 2 to 5 o'clock in the afternoon, and the hustling get-ready scenes of the morning are repeated in the discharging of the fares at the Gorton-Pew Wharf. Right here it might be stated that in twenty minutes from the time the fish are hauled up from the boat to the wharf they are ready to be canned.

The fish are hoisted to the wharf in baskets, pitched into the scales and weighed, and are then ready for the skinner. There are six of these, each located at a table in the open air on the wharf. Each skinner fills his table full of the fish, with the exception of the extreme left-hand end. Here is a raised board $2\frac{1}{2}$ feet long and 8 inches wide, at the end of which, farthest from the workman, is a big protruding spike set at a slight angle, canting away from the worker. On this board the dogfish is laid back up, the sharp spike through the head holding the fish in position. The back fins are first cut off, and then the tail. Next a swift stroke is made just through the skin from the back fin nearest the tail to the head; another dexterous flash of the knife severs the skin at the gills, and with a "hand

hold" thus secured on the skin on each side by the latter move the worker with a quick haul and a slat separates at one movement the skin, entrails, liver and all from the white gleaming flesh of the fish. The head is quickly severed and the carcass is dropped into a barrel filled with filtered salt water, while the liver, which is later tried out for oil of fine quality, is dropped into another barrel near by. The skins are saved and salted for use later in experiments as to possible use as leather. The rest is refuse.

The skinned fish, after a careful hand-cleaning by keen-eyed men, is now ready for the cutter, — a cylindrical arrangement of knives which cuts the body into just the lengths to fit the can. The whole fish is fed into this machine by another man, the work of the skinner being ended when the body and liver are dropped into their respective barrels.

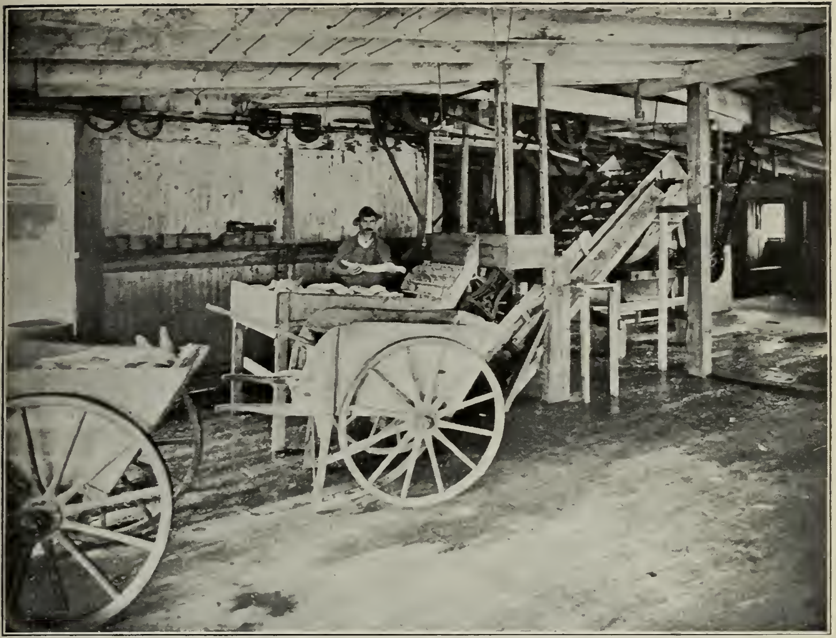
It might be noted in passing that these skinners are men of unusual skill and celerity in the use of the knife, and their wages during the season vary from $30 to $77 a week, according to the amount of fish landed. The latter amount is of course unusual, but was actually made by one of the splitters, who also made a week's wages of $70 and in that vicinity. Fifty dollars a week is said to be, however, about the usual. The pay earned is cited to show that every effort is made to have the fish in the cans with the least possible delay, and that these expert knifemen really work "like lightning."

As the fish emerge from the cutter in can lengths the pieces drop into the cleaner, — a large, long metal cylinder bored full of holes of various sizes, — which revolves rapidly while the filtered water rushes through with considerable force, thus cleansing every place thoroughly. From this cylinder as it revolves the pieces emerge at the farther end and drop into what are known as sanitary baskets so woven that they can be thoroughly cleaned after every trip to the canning room. These baskets are of the "braided" type, 1½ feet square and only 6 inches deep.

As they are filled, men take them a short distance to where an endless chain, fitted every 2 feet with lags from which depend hooks, runs constantly over a pickling tank about 70 feet in length and filled with a pickling solution in which

The removal of the "pelt."

Cleaning before entering the cutter.



Chopping to can lengths, and elevating.

Metal basket, with sealed cans filled with the meat of the dogfish, entering the steam cooker.

filtered sea water is again used. On every hook as it comes along a basket is hung, the hook being of just the right length to allow the basket with its contents to move fully submerged through the pickling bath. The baskets move through the bath slowly, taking just long enough in the passage to give the fish the proper treatment to assure its preservation and also its holding its natural flavor.

At the farther end of the pickling tank the endless chain carries the baskets of fish to the second story, where they are taken off as soon as they arrive, and the fish dumped on a broad traveling belt, the empty baskets being returned on the chain hooks to the point whence they started, there to be filled and take the journey over again.

The fish on the belt or conveyer run along to the packing machine, where the whole process of packing is done automatically. The packing machine is the same as used on the Pacific coast for the packing of salmon. Following the packing, the filled cans being thrown out on a revolving cylinder where they are sealed, the cans are taken in great baskets of steel hoops, capable of holding 1,400 cans, on a traveling overhead arrangement to the cookers or retorts, where they are cooked in the steam bath. There are five of these cookers.

Following the cooking which is timed to a nicety, as is every other part of the process, the steel baskets and their contents are hoisted out, and on the same overhead railway are shunted along to a sort of bin, where they are subjected to a cooling process, this being effected by sprays of water which jut with great force through the small holes in several pipes so arranged that the water strikes evenly over all the cans.

Thoroughly cooled, the cans are then loaded on small trucks, and after being subjected to rigid testing to see that every can is perfect — any not so being condemned — the cans are fed on to an endless belt which conveys them to the packing room, where a labeling machine works at the rate of a case in thirty seconds, and from which the girls take them and pack them into boxes, each containing 48 cans. Shippers soon have the covers on, a stencil places the address of the customer, and the grayfish, untouched by hands from the time of leaving the cleaner, is ready for the consumer's table.

## RECOMMENDATIONS FOR LEGISLATION.

The Board of Commissioners on Fisheries and Game respectfully recommends the passage of laws designed to accomplish the following purposes: —

1. To provide for exhibitions and other means of interesting and educating the public in the conservation and propagation of birds, fish and game in the Commonwealth.

2. To provide for the purchase of land on Marthas Vineyard for the establishment of a permanent reservation for the heath hen and other game, song and insectivorous birds.

3. To provide for additions and replacements at the hatcheries and game farms under the control of the Board of Commissioners on Fisheries and Game.

4. To provide for the construction or re-establishment of fishways.

5. To so amend the trapping laws as to avoid conflict with the laws relating to the observance of the Sabbath.

6. To empower the Governor and Council to suspend the laws relative to fish and game during closed seasons.

7. To reimburse Peter P. Monahan for sums expended in consequence of injuries received while in the performance of his duty in the service of the Commonwealth.

8. To authorize the Board of Commissioners on Fisheries and Game to take land by right of eminent domain.

9. To repeal chapter 138 of the Acts of the year 1902, relative to the inspection of fish.

10. To embody the trout laws in one act.

11. To separate the salmon law from the trout law and embody it in a separate act.

Respectfully submitted,

WILLIAM C. ADAMS.
GEORGE H. GRAHAM.
ARTHUR L. MILLETT.

# APPENDIX.

## STATISTICS.

*Returns from the Shore Net and Pound Fisheries for the Year 1917.*

| Proprietor. | Town. | Apparatus employed. | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Number of Men. | Number of Boats. | Value. | Number of Pounds. | Value. | Number of Nets. | Value. |
| Frank Hodgkins,<br>Preston Marchmont, | Annisquam, | 11 | 7 | $2,658 | - | - | 104 | $2,050 |
| Cape Cod Freezing and Packing Company,<br>Ensign Jerauld, | Barnstable, | 9 | 5 | 1,150 | 2 | $4,000 | - | - |
| J. E. Eldredge,<br>Gilbert Ellis,<br>Fred Young, | Brewster, | 5 | 6 | 80 | 11 | 2,400 | 2 | 40 |
| Geo. Bearse,<br>Roscoe Gould,<br>T. W. Holway, | Chatham, | 9 | 9 | 1,760 | 2 | 2,000 | 25 | 250 |
| Don R. Campbell,<br>E. C. Flanders & Co.,<br>Daniel West, | Chilmark, | 8 | 10 | 1,500 | 24 | 2,400 | - | - |
| Geo. A. Finney, | Chiltonville, | 3 | 4 | 85 | - | - | - | - |
| Jerry McCarthy, | Cohasset, | 1 | 2 | 160 | - | - | - | - |
| George C. King, | Cuttyhunk, | 2 | 6 | 1,730 | 2 | 2,000 | - | - |
| Ansel P. Howes,<br>Isaac Tucker, | Dennis, | 3 | 3 | 50 | - | - | 13 | 30 |

*Returns from the Shore Net and Pound Fisheries for the Year 1917* — Concluded.

| Proprietor. | Town. | Apparatus employed. | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Number of Men. | Number of Boats. | Value. | Number of Pounds. | Value. | Number of Nets. | Value. |
| Chas. Gardner,<br>E. D. Perry, | Dighton, | 6 | 6 | $410 | - | - | 4 | $250 |
| Harry Hunt, | Duxbury, | 9 | 5 | 2,530 | - | - | - | - |
| Chas. F. Tarr, | East Gloucester, | 1 | 4 | 345 | - | - | 3 | 500 |
| John Brown,<br>Chas. W. Cook,<br>J. B. Goulart, | Fairhaven, | 4 | 6 | 333 | 3 | $367 | - | - |
| Jos. Douglas,<br>Henry W. Nelson, | Gloucester, | 3 | 9 | 700 | - | - | 2 | 700 |
| Ansel Taylor, | Hyannis, | 2 | 4 | 2,060 | - | - | 37 | 650 |
| Edw. W. Heath, | Manchester, | 3 | 5 | 80 | 1 | 3,000 | - | - |
| John Gilbert,<br>Wm. H. Tutt, | Marblehead, | 2 | 4 | 570 | - | - | - | - |
| H. D. Powell,<br>Avard Smith, | Nahant, | 9 | 7 | 1,465 | 2 | 2,000 | - | - |
| A. J. Barrett Company,<br>E. H. Pease, | Nantucket, | 12 | 16 | 3,800 | 2 | 2,000 | 104 | 2,200 |
| C. A. Caswell & Co., | Newburyport, | 2 | 1 | 35 | - | - | 1 | 30 |
| A. R. Norton, | Oak Bluffs, | 6 | - | - | - | - | - | - |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Manuel James,<br>John Johnson,<br>Jas. E. Kelley,<br>Wm. B. Lewis,<br>Alfred Mayo,<br>H. L. Mayo,<br>Martin Nelson,<br>Frank I. Sears,<br>Manuel Vera,<br>J. R. Williams,<br>Edwin Smith, | Provincetown, | 31 | 29 | 19,603 | 6 | 6,200 | 230 | 3,600 |
| Edw. Williams, | Raynham, | 12 | 4 | 400 | - | - | 3 | 300 |
| John Nelson, | Rockport, | 3 | 3 | 332 | 42 | 230 | - | - |
| E. W. Haines, | Sandwich, | 2 | 3 | 425 | - | - | 1 | 1,000 |
| A. N. Goff, | Segregansett, | 16 | 3 | 105 | - | - | 4 | 200 |
| J. H. Miller, | Somerset, | 7 | 5 | 160 | - | - | - | - |
| Edgar N. Baker, | South Yarmouth, | 5 | 2 | 28 | - | - | 3 | 25 |
| Obed S. Daggett,<br>George H. Luce,<br>H. Nelson Luce,<br>Otis B. Luce, | Tisbury, | 9 | 21 | 1,520 | 11 | 4,900 | - | - |
| C. E. T. Benson,<br>Thos. Tilton, | Vineyard Haven, | 3 | 6 | 225 | 2 | 675 | - | - |
| E. P. Cook, | Wellfleet, | - | - | - | - | - | 1 | 15 |
| A. S. Hall, | West Brewster, | 6 | 4 | 640 | 2 | 2,000 | - | - |
| Zenas Baker, | West Dennis, | 8 | 4 | 1,020 | 2 | 2,000 | - | - |
| J. R. Fish, Jr., | Westport Point, | 3 | 5 | 410 | 1 | 500 | - | - |
| D. T. Butler, | West Tisbury, | 1 | 2 | 180 | 2 | 200 | - | - |
| Shirley D. Lovell, | Yarmouthport, | 3 | 6 | 1,550 | 1 | 100 | 60 | 600 |
| Totals, | | 219 | 216 | $48,099 | 118 | $36,972 | 597 | $12,440 |

*Number of Pounds of Fish taken*

| Town. | Alewives. | Bluefish. | Flounders. | Mackerel. | Menhaden. | Pollock. | Cod. | Scup. |
|---|---|---|---|---|---|---|---|---|
| Annisquam, | - | - | 39,237 | 6,428 | 11,187 | 4,200 | 40,880 | - |
| Barnstable, | - | - | - | 86,105 | - | 4,885 | 1,575 | - |
| Bay View, | - | - | - | - | - | - | - | - |
| Beverly, | - | - | - | - | - | - | - | - |
| Bournedale, | - | - | - | - | - | - | - | - |
| Brewster, | 21,815 | 232 | 1,228 | 25,773 | - | 1,300 | - | - |
| Chatham, | 4,700 | 127 | 8,250 | 97,069 | - | 420 | 150 | 1,900 |
| Chilmark, | - | 50,150 | 7,091 | 53,531 | - | - | - | 20,542 |
| Chiltonville, | - | - | - | 1,900 | - | - | - | - |
| Cohasset, | - | - | - | - | - | - | - | - |
| Cuttyhunk, | - | - | 553 | 1,070 | - | 1,575 | 181 | - |
| Dennis, | - | - | - | 450 | - | - | - | - |
| Dighton, | 1,300 | - | - | - | - | - | - | - |
| Duxbury, | - | - | - | 41,985 | - | - | - | - |
| East Gloucester, | - | - | - | 9,500 | - | 49,000 | 1,950 | - |
| East Mattapoisett, | - | - | - | - | - | - | - | - |
| Fairhaven, | 600 | 1,213 | 508 | 2,664 | 80 | - | 50 | 444 |
| Gay Head, | - | - | - | - | - | - | - | - |
| Gloucester, | 5,000 | - | - | 11,300 | - | 175,000 | - | - |
| Gosnold, | - | - | - | - | - | - | - | - |
| Green Harbor, | - | - | - | - | - | - | - | - |
| Hyannis, | - | - | 102,720 | 17,037 | - | - | - | - |
| Hyannisport, | - | - | - | - | - | - | - | - |
| Kingston, | - | - | - | - | - | - | - | - |
| Lanesville, | - | - | - | - | - | - | - | - |
| Manchester, | 2,696 | - | - | 18,168 | - | 21,614 | 370 | 3,217 |
| Manomet, | - | - | - | - | - | - | - | - |
| Marblehead, | 126 | - | 3,722 | 180 | - | - | 4,500 | - |
| Minot, | - | - | - | - | - | - | - | - |
| Nahant, | - | - | - | 686 | - | - | - | - |
| Nantucket, | 74,000 | - | 5,550 | 140,500 | - | 12,470 | - | 600 |
| Newburyport, | - | - | - | - | - | - | - | - |
| North Chatham, | - | - | - | - | - | - | - | - |
| Oak Bluffs, | - | - | - | - | - | - | - | - |
| Orleans, | - | - | - | - | - | - | - | - |

*in Pounds, Nets, Traps, etc., 1917.*

| Haddock. | Sea Herring. | Shad. | Squeteague. | Hake. | Squid. | Tautog. | Other Edible or Bait Species. | Lobsters. | Total Weight. | Total Value. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1,148 | 230,200 | - | - | - | - | - | - | - | 333,280 | $6,490 35 |
| - | 54,550 | 405 | - | - | 231,550 | 715 | 679,222 | - | 1,059,007 | 11,962 59 |
| - | - | - | - | - | - | - | - | 1,491 | 1,491 | 355 82 |
| - | - | - | - | - | - | - | - | 5,077 | 5,077 | 1,020 00 |
| - | - | - | - | - | - | - | - | 16,266 | 16,266 | 2,832 73 |
| - | 160,635 | 736 | - | - | 6,349 | 421 | 26,252 | - | 244,741 | 5,235 98 |
| - | 58,500 | 470 | - | - | 271,775 | 1,500 | 59,980 | 2,040 | 506,881 | 10,161 98 |
| - | - | - | 130 | 32,800 | 400 | - | 112,297 | 24,565 | 301,506 | 13,094 65 |
| - | - | - | - | - | 12,300 | 250 | 3,040 | 9,190 | 26,680 | 2,112 70 |
| - | - | - | - | - | - | - | 561 | 35,602 | 36,163 | 6,134 25 |
| - | - | - | - | 528 | - | - | 226,670 | 38,392 | 268,969 | 5,290 15 |
| - | - | - | - | - | - | - | 1,200 | 7,981 | 9,631 | 1,352 65 |
| - | - | 24 | - | - | - | - | 1,607 | - | 2,931 | 211 45 |
| - | 752,300 | - | - | - | - | - | - | 1,270 | 795,555 | 8,091 00 |
| - | 2,000 | - | - | - | 15,000 | - | 31,100 | - | 108,550 | 1,537 50 |
| - | - | - | - | - | - | - | - | 628 | 628 | 125 99 |
| 200 | - | 1,004 | 9 | - | 1,834 | 125 | 3,383 | 14,164 | 26,278 | 2,397 37 |
| - | - | - | - | - | - | - | - | 21,729 | 21,729 | 3,390 77 |
| - | 17,000 | - | - | - | 6,000 | - | 1,368,000 | 12,897 | 1,595,197 | 7,760 75 |
| - | - | - | - | - | - | - | - | 11,250 | 11,250 | 1,400 00 |
| - | - | - | - | - | - | - | - | 22,882 | 22,882 | 3,708 00 |
| - | - | - | - | - | - | - | - | - | 119,757 | 4,307 79 |
| - | - | - | - | - | - | - | - | 1,027 | 1,027 | 263 67 |
| - | - | - | - | - | - | - | - | 6,949 | 6,949 | 1,387 44 |
| - | - | - | - | - | - | - | - | 7,162 | 7,162 | 853 86 |
| - | 112,596 | 333 | - | - | 14,459 | - | 139,494 | 12,817 | 325,764 | 6,354 63 |
| - | - | - | - | - | - | - | - | 39,439 | 39,439 | 5,878 58 |
| - | - | - | - | - | - | - | - | 75,070 | 83,598 | 16,485 51 |
| - | - | - | - | - | - | - | - | 4,197 | 4,197 | 990 33 |
| - | 232,250 | - | - | - | 1,190 | - | 299,888 | 2,086 | 536,100 | 3,904 80 |
| - | 13,000 | 200 | - | 6,000 | - | 9,000 | 40,500 | 27,130 | 328,950 | 18,385 42 |
| - | - | - | - | - | - | - | 17,784 | - | 17,784 | 552 30 |
| - | - | - | - | - | - | - | - | 1,884 | 1,884 | 545 84 |
| - | - | - | - | - | - | - | 578 | - | 578 | 97 27 |
| - | - | - | - | - | - | - | - | 2,020 | 2,020 | 538 80 |

*Number of Pounds of Fish taken*

| Town. | Alewives. | Bluefish. | Flounders. | Mackerel. | Menhaden. | Pollock. | Cod. | Scup. |
|---|---|---|---|---|---|---|---|---|
| Pigeon Cove, | – | – | – | – | – | – | – | – |
| Plymouth, | – | – | – | – | – | – | – | – |
| Provincetown, | – | – | 924,871 | 158,285 | – | 20,690 | 5,000 | – |
| Raynham, | 24,558 | – | – | – | – | – | – | – |
| Rockport, | – | – | – | 700 | – | – | – | – |
| Sagamore, | – | – | – | – | – | – | – | – |
| Salem, | – | – | – | – | – | – | – | – |
| Sandwich, | – | – | – | 2,238 | – | – | – | – |
| Scituate, | – | – | – | – | – | – | – | – |
| Segregansett, | 23,200 | – | – | – | – | – | – | – |
| Somerset, | 24,156 | – | – | – | – | – | – | – |
| South Boston, | – | – | – | – | – | – | – | – |
| South Duxbury, | – | – | – | – | – | – | – | – |
| South Yarmouth, | – | – | – | – | – | – | – | – |
| Tisbury, | 3,770 | 90 | 22,757 | 82,313 | – | 150 | – | 9,202 |
| Vineyard Haven, | 11,900 | – | 2,150 | 7,800 | – | – | – | 725 |
| Wellfleet, | 17,600 | – | – | – | – | – | – | – |
| West Brewster, | 70,000 | – | 30,000 | – | – | – | – | 6,000 |
| West Dennis, | 53,769 | – | – | 35,179 | – | – | – | 200 |
| Westport Point, | 1,818 | 32 | 1,421 | 8,411 | – | 11 | 700 | 24 |
| West Tisbury, | 30,000 | – | – | – | – | – | – | – |
| Weymouth, | – | – | – | – | – | – | – | – |
| White Horse Beach, | – | – | – | – | – | – | – | – |
| Woods Hole, | – | – | – | – | – | – | – | – |
| Yarmouth, | – | – | – | – | – | – | – | – |
| Yarmouthport, | – | 650 | – | 60,000 | – | 7,200 | 77,600 | – |
| Totals, | 371,008 | 52,494 | 1,150,058 | 869,272 | 11,267 | 298,515 | 132,956 | 42,854 |

*in Pounds, Nets, Traps, etc., 1917* — Concluded.

| Haddock. | Sea Herring. | Shad. | Squeteague. | Hake. | Squid. | Tautog. | Other Edible or Bait Species. | Lobsters. | Total Weight. | Total Value. |
|---|---|---|---|---|---|---|---|---|---|---|
| – | – | – | – | – | – | – | – | 345 | 345 | $64 89 |
| – | – | – | – | – | – | – | – | 33,183 | 33,183 | 6,228 50 |
| – | 175,200 | – | – | – | 332,085 | – | 679,322 | 1,629 | 2,297,082 | 51,510 92 |
| – | – | 5 | – | – | – | – | – | – | 24,563 | 650 47 |
| – | – | – | – | – | – | – | – | 68,433 | 69,133 | 2,123 39 |
| – | – | – | – | – | – | – | – | 1,644 | 1,644 | 305 00 |
| – | – | – | – | – | – | – | – | 14,481 | 14,481 | 4,085 74 |
| – | 23,000 | 105 | – | – | 97,678 | 349 | 117,055 | 6,997 | 247,422 | 3,692 25 |
| – | – | – | – | – | – | – | – | 4,680 | 4,680 | 645 54 |
| – | – | 48 | – | – | – | – | 2,000 | – | 25,248 | 1,429 60 |
| – | – | 3 | – | – | – | – | – | – | 24,159 | 604 50 |
| – | – | – | – | – | – | – | – | 4,425 | 4,425 | 1,032 00 |
| – | – | – | – | – | – | – | – | 1,327 | 1,327 | 491 50 |
| – | – | – | – | – | – | – | 58,416 | – | 58,416 | 10,408 00 |
| 40 | 150 | 150 | 1,880 | – | 11,600 | 2,817 | 8,484 | 1,827 | 145,230 | 7,839 73 |
| – | – | 25 | 550 | – | – | 470 | 2,250 | 3,844 | 29,714 | 1,906 21 |
| – | – | – | – | – | – | – | 100 | – | 17,700 | 448 00 |
| – | – | – | – | 500 | – | – | 89,000 | – | 195,500 | 5,609 00 |
| – | 20,000 | 4,500 | – | – | 13,085 | 960 | – | – | 127,693 | 2,858 41 |
| – | 986 | 95 | 7 | – | 110 | 15 | 42,346 | 15,016 | 70,992 | 3,660 21 |
| – | – | – | – | – | – | – | – | 9,465 | 39,465 | 1,430 18 |
| – | – | – | – | – | – | – | – | 8,086 | 8,086 | 2,434 81 |
| – | – | – | – | – | – | – | – | 8,788 | 8,788 | 1,426 50 |
| – | – | – | – | – | – | – | – | 13,596 | 13,596 | 1,842 16 |
| – | – | – | – | – | – | – | – | –[1] | –[1] | 720 52 |
| – | 127,400 | – | – | – | – | 800 | 8,800 | 720 | 283,170 | 9,488 26 |
| 1,388 | 1,979,767 | 8,103 | 2,576 | 39,828 | 1,015,415 | 17,422 | 4,019,329 | 603,691 | 10,615,943 | $278,149 21 |

[1] Number and weight not reported.

*Returns from the Lobster Fisheries, 1917.*

| Proprietor. | Town. | Number of Men. | Number of Boats. | Value. | Number of Pots. | Value. | Number of Lobsters. | Value. | Number of Egg-bearing Lobsters. |
|---|---|---|---|---|---|---|---|---|---|
| Chas. Wilson, | Bay View, | 1 | 1 | $25 00 | 65 | $162 50 | 994 | $355 82 | – |
| Warland Hersey, | Beverly, | 2 | 2 | 125 00 | 60 | 100 00 | 3,385 | 1,020 00 | 87 |
| Jos. Casson,<br>Frank E. Leonard,<br>A. Nightingale,<br>R. W. Nightingale,<br>W. R. Nightingale, | Bournedale, | 5 | 9 | 725 00 | 280 | 425 00 | 10,844 | 2,832 73 | 98 |
| Fred W. Baker,<br>W. W. Eldredge,<br>Chas. Hamilton, | Chatham, | 3 | 6 | 825 00 | 110 | 225 00 | 1,360 | 187 48 | 50 |
| Jerry Look,<br>Benj. C. Mayhew,<br>Wm. S. Mayhew,<br>Everett A. Poole,<br>Harry G. Reed,<br>Ralph Tilton, | Chilmark, | 7 | 9 | 1,895 00 | 442 | 876 00 | 16,377 | 3,807 60 | 232 |
| Jos. Boutin,<br>Ernest Johns, | Chiltonville, | 2 | 4 | 360 00 | 153 | 326 00 | 6,127 | 1,605 60 | 50 |
| Henry Kimball,<br>Geo. T. Ainslee,<br>Foster Cadose,<br>Levi Cadose,<br>John Eltman,<br>Antone Figueredo,<br>Antone Grassie,<br>Jerry McCarthy,<br>John Silvia,<br>Jos. M. Silvia, | Cohasset, | 11 | 16 | 2,688 00 | 1,424 | 2,413 25 | 23,735 | 6,120 46 | 176 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Jos. Canaia,<br>Thos. B. Dowling,<br>Isaac Gregory,<br>Geo. C. King,<br>Frank C. Peters, | Cuttyhunk, | 7 | 14 | 3,665 00 | 595 | 1,025 00 | 25,595 | 4,942 63 | 87 |
| Geo. E. Hall,<br>Ansel P. Howe,<br>Isaac Tucker,<br>Benj. Walker,<br>Oscar Gibbs, | Dennis, | 6 | 9 | 190 00 | 335 | 270 00 | 5,321 | 1,249 65 | 147 |
| S. J. Wadsworth, | Duxbury, | 1 | 2 | 20 00 | 40 | - | 847 | - | - |
| Wm. H. Raymond,<br>W. R. Spooner, | East Mattapoisett, | 2 | 4 | 412 00 | 29 | 48 00 | 419 | 125 49 | 11 |
| Antone Brown,<br>Chas. W. Cooke,<br>A. Roderique,<br>Joe Rose, | Fairhaven, | 4 | 6 | 680 00 | 255 | 295 00 | 9,443 | 1,974 53 | 144 |
| Granville Belain,<br>Moses P. Cooper,<br>N. A. Frances,<br>J. H. Lang,<br>J. A. Mayhew & Co.,<br>A. Reinertson,<br>Chas. H. Ryan, | Gayhead, | 9 | 19 | 1,742 00 | 428 | 733 00 | 14,486 | 3,390 77 | 130 |
| Edw. L. Ashley,<br>Jos. Douglass,<br>W. Marchmont,<br>D. E. Mehlman, | Gloucester, | 4 | 8 | 375 00 | 235 | 480 00 | 8,598 | 2,480 70 | 68 |
| A. P. Tilton, | Gosnold, | 1 | 1 | - | 150 | 300 00 | 7,500 | 1,400 00 | - |
| Geo. Delano,<br>W. Keene,<br>W. M. Englestead,<br>C. E. Peterson,<br>Chas. Peterson,<br>R. G. Peterson,<br>Lyman Sears, | Green Harbor, | 7 | 15 | 1,585 00 | 665 | 1,330 00 | 15,255 | 3,708 80 | 228 |

*Returns from the Lobster Fisheries, 1917* — Continued.

| Proprietor. | Town. | Number of Men. | Number of Boats. | Value. | Number of Pots. | Value. | Number of Lobsters. | Value. | Number of Egg-bearing Lobsters. |
|---|---|---|---|---|---|---|---|---|---|
| N. Marchant, | Hyannisport, | 1 | 3 | $190 00 | 50 | $50 00 | 685 | $263 67 | - |
| Henry S. West, Chas. Whitney, | Kingston, | 3 | 4 | 1,155 00 | 100 | 250 00 | 4,633 | 1,387 44 | 36 |
| Alfred W. Riley, A. Woodbury, G. Woodbury, | Lanesville, | 3 | 4 | 330 00 | 175 | 250 00 | 4,775 | 853 86 | 25 |
| Frank Blaney, Gus Ferrarra, | Manchester, | 2 | 4 | 547 00 | 160 | 360 00 | 8,545 | 2,132 80 | 69 |
| E. H. Arnold, E. H. Bartlett, Saml. Benson, G. L. Binney, David H. Briggs, Laban Briggs, Jr., Laban Briggs, Sr., Jas. E. Burke, H. D. Cleveland, Chas. H. Dixon, C. H. Dixon, Ed. L. Dixon, Geo. W. Holmes, Myron F. Manter, F. R. Peterson, Ralph Holmes, | Manomet, | 17 | 28 | 1,660 00 | 805 | 1,632 50 | 26,293 | 5,878 58 | 227 |
| Wm. F. Allen, Chas. O. Briggs, John Brown, Ernest Cronk, Chas. H. Foss, Isaac Freeto, Arthur Frost, W. T. Gardner, | | | | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Frank Gilbert,<br>J. G. Gilbert,<br>David P. Howe,<br>John G. Howe,<br>Wm. T. Howe,<br>L. Letourneau,<br>John W. Mace,<br>Everett Magee,<br>Jas. H. Magee,<br>Harry Oliver,<br>Jas. S. Phillips,<br>Aug. K. Roundy,<br>Richard Russell,<br>Chas. H. Smith,<br>Steven Smith,<br>Wm. F. Smith,<br>Ebenezer Snow,<br>John S. Stacy,<br>John R. Stacy,<br>Wm. H. Tutt,<br>J. S. Witham, | Marblehead, | 31 | 50 | 5,300 00 | 490 | 2,233 75 | 50,047 | 14,726 56 | 711 |
| Chas. De Costa,<br>R. Gargone,<br>Eugene Pratt,<br>Danl. Sylvester, | Minot, | 7 | 10 | 357 00 | 280 | 345 00 | 2,798 | 990 33 | 30 |
| G. H. Lamphier, | Nahant, | 1 | 2 | 175 00 | 60 | 90 00 | 1,391 | 570 00 | 16 |
| Chas. Eldredge,<br>A. B. Grant,<br>Walter Jewett,<br>Wm. B. Lewis,<br>Joe Mayo,<br>Ellison Pease,<br>Edw. H. Rose,<br>Elliot Wheldon, | Nantucket, | 10 | 13 | 2,755 00 | 420 | 645 00 | 18,087 | 3,998 92 | 177 |
| B. R. Baker,<br>Eugene Eldredge, | North Chatham, | 2 | 2 | 160 00 | 220 | 310 00 | 1,256 | 545 84 | 79 |
| Dan'l B. Gould, | Orleans, | 1 | 1 | 250 00 | 80 | 160 00 | 1,347 | 538 80 | 47 |
| Chas. Currier, | Pigeon Cove, | 1 | 1 | 10 00 | 20 | 20 00 | 230 | 64 89 | 13 |

*Returns from the Lobster Fisheries, 1917* — Continued.

| Proprietor. | Town. | Number of Men. | Number of Boats. | Value. | Number of Pots. | Value. | Number of Lobsters. | Value. | Number of Egg-bearing Lobsters. |
|---|---|---|---|---|---|---|---|---|---|
| Geo. Atwell, Jas. A. Bagnall, Albert Boutin, H. J. Caswell, Harold Hadaway, J. R. Harlow, Albert F. Pierce, J. Albert Russell, H. S. Sampson, Frank Simmons, Levi Thurston, John Watkins, Leo White, | Plymouth, | 13 | 22 | $3,230 00 | 824 | $1,685 00 | 22,122 | $6,228 50 | 147 |
| Cushing Emery, John Savage, Sam'l Smith, Manuel Snow, | Provincetown, | 4 | 4 | 60 00 | 151 | 171 00 | 1,086 | 528 54 | 132 |
| C. P. Babson, Wm. Bennett, E. Bowman, Jr., Chester Gott, John Lawson, Carl Nelson, Ernest Nelson, John Nelson, Arthur Norwood, Hans Palmquist, Arthur Rich, Sam'l Thurston, Geo. Wendell, Wm. E. Norwood, | Rockport, | 15 | 20 | 2,492 50 | 1,160 | 1,992 50 | 45,622 | 11,989 39 | 326 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Arthur Gibbs, | Sagamore, | 1 | 3 | 75 00 | 60 | 60 00 | 1,096 | 305 00 | 43 |
| Chas. H. Berry,<br>Geo. W. Dunn,<br>John A. Dunn, | Salem, | 4 | 6 | 970 00 | 200 | 410 00 | 9,654 | 4,085 74 | 72 |
| A. S. Hamblin,<br>John F. Mahoney, | Sandwich, | 2 | 4 | 381 00 | 95 | 95 00 | 4,665 | 1,829 91 | – |
| Thos. S. Turner,<br>Dan'l Ward, | Scituate, | 2 | 4 | 316 00 | 140 | 315 00 | 3,120 | 645 54 | 3 |
| Jos. Serrella, | South Boston, | 3 | 6 | 825 00 | 250 | 400 00 | 2,950 | 1,032 00 | 236 |
| Frank Phillips, | South Duxbury, | 2 | 2 | 360 00 | 25 | 35 00 | 885 | 491 50 | 2 |
| Geo. H. Luce,<br>H. Nelson Luce, | Tisbury, | 3 | 7 | 660 00 | 40 | 50 00 | 1,218 | 219 80 | 30 |
| T. M. Chace,<br>Edw. Cleveland,<br>T. T. Tilton, | Vineyard Haven, | 4 | 8 | 615 00 | 85 | 145 00 | 2,563 | 669 19 | 65 |
| J. R. Fish, Jr.,<br>Wm. S. Head,<br>H. G. Sowle,<br>Wm. B. Whalon, | Westport Point, | 5 | 9 | 1,730 00 | 230 | 475 00 | 10,011 | 2,141 75 | 104 |
| David Butler,<br>L. D. Mayhew, | West Tisbury, | 2 | 3 | 683 00 | 150 | 200 00 | 6,310 | 1,415 18 | – |
| F. J. Carr, | Weymouth, | 1 | 1 | 200 00 | 150 | 150 00 | 5,391 | 2,434 81 | 38 |
| W. P. Alexander,<br>S. Blackmer,<br>John Brierly,<br>W. Hamilton,<br>G. W. Keith, | White Horse Beach, | 5 | 8 | 630 00 | 217 | 311 00 | 5,859 | 1,426 50 | 17 |

*Returns from the Lobster Fisheries, 1917* — Concluded.

| Proprietor. | Town. | Number of Men. | Number of Boats. | Value. | Number of Pots. | Value. | Number of Lobsters. | Value. | Number of Egg-bearing Lobsters. |
|---|---|---|---|---|---|---|---|---|---|
| Jas. F. Cooke, C. M. Fisher, Alfred Hilton, Oscar Hilton, W. E. Nickerson, H. A. Phinney, P. M. Stuart, A. C. Swain, Jr., Robt. Veeder, | Woods Hole, | 9 | 12 | $778 00 | 252 | $414 00 | 9,064 | $1,842 16 | 84 |
| Elmer Newell, | Yarmouth, | 1 | - | - | 100 | 160 00 | - | 720 52 | 250 |
| Shirley Lovell, | Yarmouthport, | 3 | 6 | 1,550 00 | 100 | 125 00 | 480 | 218 00 | 6 |
| Totals, | | 230 | 372 | $43,756 50 | 12,355 | $22,548 50 | 402,469 | $105,377 98 | 4,493 |

Montague Rearing Station. Temporary hatching house, showing spring that was dammed up for water supply. Four-inch pipe conducts the water to hatching house.

Public Document No. 25

# FIFTY-FOURTH ANNUAL REPORT

OF THE

Mass:

# COMMISSIONERS

ON

# FISHERIES AND GAME

FOR THE

YEAR ENDING NOVEMBER 30, 1919

BOSTON
WRIGHT & POTTER PRINTING CO., STATE PRINTERS
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1920

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approved by the
Supervisor of Administration.

# COMMISSIONERS ON FISHERIES AND GAME.

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WILLIAM C. ADAMS, NEWTONVILLE (*Chairman*).
GEORGE H. GRAHAM, SPRINGFIELD.
ARTHUR L. MILLETT, GLOUCESTER.

**Secretary.**

MISS L. B. RIMBACH.

**Chief Deputy Commissioner.**

ORRIN C. BOURNE.

**Supervisor of Fish and Game Distribution.**

W. RAYMOND COLLINS.

**Biologist.**

DAVID L. BELDING.

OFFICE: Room 321, State House, Boston, Mass.

## CONTENTS.

# The Commonwealth of Massachusetts

*To His Excellency the Governor and the Honorable Council.*

The Board of Commissioners on Fisheries and Game respectfully submit their fifty-fourth annual report.

## GENERAL CONSIDERATIONS.

During the war our Board believed it to be its duty to resist the efforts of certain elements to exhaust the wild-life resources of the State to help relieve certain conditions which had arisen, namely, shortage and high cost of food. Such utilization of these resources would have been of little assistance, but would have resulted, had the wishes of some people been met, in consuming the brood stock on which the hopes of the future must rest. We have only to survey the wild-life resources of the nations most affected by the war to realize what this means. By reason of the withdrawal of food supplies, the reduction of gamekeepers and others who exterminate vermin, the consequent rapid increase of vermin, and the almost complete failure to continue restocking operations, the wild life in these countries to-day has been set back so far that it will require long years to restore even the pre-war conditions. The realization that the Commonwealth has been protected from such ravages should be a matter of great thanksgiving among the people of the State.

The mounting costs of materials and the scarcity of labor required that during this period our various enterprises should be operated at the economic minimum rather than the maximum, though a comparison of figures for the past few years will show that, despite the various handicaps, a reasonable production was kept up at all our stations.

Shortly after the beginning of this fiscal year the signing of the armistice seemed to presage more normal conditions, but our experience was that the difficulties of the work increased rather

than diminished. It was necessary to constantly revise our financial program and to postpone many replacement and repair matters, which, though reasonably inexpensive and calculated to bring very substantial returns, funds would not permit us to make. Every effort was put forth to prevent depreciation in the property under our control, though little new construction was undertaken.

Appreciating the great demands on the taxpayers of the Commonwealth we placed in our budget for the year only such items of new construction as were regarded as emergencies.

The one outstanding feature is, that we have preserved the wild life of the Commonwealth, and we should all be enthusiastic to go forward with a program calculated to further protect, and annually to substantially increase it. This will call for certain further restrictions in the taking of fish and game. In the light of our new Americanism it should appear reasonable to withhold from the aliens in our communities the privilege of exploiting the natural resources of the Commonwealth until they have resided with us long enough to understand conditions, and until they have assumed the responsibilities of citizenship.

## Organization.

Chapter 350 of the General Acts of 1919 provides for the regrouping of all the commissions into not to exceed twenty departments. It provides for a Department of Conservation, in which will be grouped the forestry, fisheries and game and animals industry activities, headed by a State Forester, a Director of Fisheries and Game, and a Director of Animal Industry, respectively. The act further provides that the Governor shall designate one of these three officers to serve as the Commissioner of Conservation at the head of the department. The two remaining heads of divisions shall act as an advisory council to the commissioner. The act takes effect on Dec. 1, 1919.

## Finances.

We have not found it necessary to make any substantial changes in our methods of handling the finances of the department, our experience confirming the wisdom of laying out a

thoroughly considered financial program at the beginning of the year, with sufficient reserves in all branches to meet emergencies. The results achieved by placing the several branches of the work in charge of representatives who are held personally responsible for results has proved the advisability of retaining this form of organization.

The appropriations for the fiscal year 1919 and available 1918 balances, together with the amounts expended, are shown in the following table: —

| Name of Appropriation. | Available 1918 Balances and Amounts appropriated in 1919. | Expended 1919. | Balances Nov. 30, 1919. |
|---|---|---|---|
| Personal services of Commissioners, | $7,500 00 | $7,500 00 | - |
| Personal services of office assistants, | 7,600 00 | 7,194 79 | $405 21 |
| Office expenses, | 11,600 00 | 11,547 32 | 52 68 |
| Enforcement of laws, | 63,700 00 | 62,840 75 | 859 25 |
| Propagation of game birds, animals and food fish, | 72,000 00 | 71,965 59 | 34 41 |
| Exhibitions, | 1,000 00 | 999 73 | 27 |
| Chapter 375, Special Acts of 1917: — | | | |
| Additions to house at Marthas Vineyard (balance forwarded from 1918). | 78 90 | - | 78 90 |
| Additions to house at Palmer (balance forwarded from 1918). | 389 10 | 78 62 | 310 48 |
| Construction of Lawrence fishway: — | | | |
| Chapter 161, Special Acts of 1918 (balance), | 8,934 17 | | |
| Chapter 211, Special Acts of 1919, | 5,000 00 | 9,802 25 | 15,131 92 |
| Chapter 242, Special Acts of 1919, | 11,000 00 | | |
| Chapter 153, Special Acts of 1919: — | | | |
| Rearing stations, | 2,500 00 | - | 2,500 00 |
| Constructing pond at Palmer, | 500 00 | - | 500 00 |
| Constructing head trough at East Sandwich, | 1,100 00 | 84 08 | 1,015 92 |
| Purchase of land at Montague, | 1,850 00 | - | 1,850 00 |
| Construction of ice house at Montague, | 300 00 | - | 300 00 |
| Construction of road at Montague, | 200 00 | - | 200 00 |
| Extending pond at Montague, | 300 00 | - | 300 00 |
| Construction of ice house at Amherst, | 300 00 | - | 300 00 |
| Construction of ice house at Pittsfield, | 300 00 | - | 300 00 |
| Construction of road at Pittsfield, | 150 00 | - | 150 00 |
| | $196,302 17 | $172,013 13 | $24,289 04 |

The amount of money received as a result of the activities of the department, and turned into the general treasury of the Commonwealth, was $72,794.39, as follows: —

| | |
|---|---|
| Nonresident hunters' licenses, at $10, | $2,428 50 |
| Nonresident hunters' licenses, at $1, | 151 25 |
| Resident hunters' licenses, at $1, | 65,308 00 |
| Alien hunters' licenses, at $15, | 1,770 50 |
| Lobster fishermen's licenses, at $1, | 776 50 |
| Nonresident fishing licenses, at $1, | 58 65 |
| Nonresident fishing licenses, at $0.50, | 1 75 |
| Resident fishing licenses, at $0.50, | 952 30 |
| Alien fishing licenses, at $1, | 47 60 |
| Receipts from game farms and fish hatcheries, | 476 48 |
| Game tags, | 7 10 |
| Sale of forfeited deer, | 598 51 |
| Lease of Chilmark Pond, | 75 00 |
| Rent of Monomoy shanty, | 10 00 |
| Unclaimed deposits on bids for building Lawrence fishway, | 9 25 |
| Sale of forfeited guns, | 123 00 |
| | $72,794 39 |

A new source of income has been provided in the combined hunting and fishing licenses, the act providing for which went into effect on Oct. 10, 1919. The purpose of the legislation is to require those who fish certain inland waters of the State to procure a license such as has been required of the hunters for a number of years past. The indications are, judged from the short time that the law has been in effect, that it will result in a substantial annual revenue.

## Activities outside the State.

### *Inspection of Migratory Bird Areas.*

In January the chairman visited various parts of Alabama for the purpose of continuing his inspection of the wild-life conditions in that portion of the country which may be described as the wintering zone. He is a member of the Federal Migratory Treaty Act Advisory Board, and it is obvious that, as one of the two members of the Board from the New England States, he

must have first-hand knowledge of the conditions which obtain in other parts of the country in order to satisfactorily discharge these duties.

*United States Fisheries Association.*

Commissioner Arthur L. Millett represented the Board at the meeting of the United States Fisheries Association in New York City from February 13 to 17, when representatives of the commercial fisheries interests met to organize into an association to be known as the United States Fisheries Association. The results of this and of the meeting on September 26 and 27, at which he was also present, are fully discussed in the section on "Marine Fisheries."

*American Game Protective Association.*

At this meeting, held March 3 and 4 in New York, Commissioner George H. Graham represented the Board.

*International Association of Fish and Game Commissioners.*

At this meeting, held at Louisville, Ky., October 6 and 7, the Board was represented by two members and the biologist.

*American Fisheries Society.*

Two members of the Board and the biologist attended the sessions of this society at Louisville, Ky., October 8 to 10. The contribution from Massachusetts was a paper on pollution of waters.

## EDUCATION.

There were no new features this year in the educational work, which was curtailed to some extent by reason of the illness of the chief deputy during the lecture season, and his absence from the office while serving in the State Guard during the period when exhibition work at the agricultural fairs was at its height. Even under these circumstances, however, a considerable amount of lecture work was done throughout the year, and the members of the Board covered a number of lecture assignments.

### Exhibitions.

At the Eastern States Exposition in West Springfield, February 14 to 20, an exhibition was made of the various species of fish and birds that are being propagated.

Nine other exhibits were made at fairs, but owing to the lack of funds it was necessary to disappoint a number of agricultural societies that desired our co-operation along this line. The work of perfecting a standard exhibit, into which annually new features will be incorporated, was continued. The visualizing of the work of the department through this means has shown results in the hearty interest in our work exhibited by people all over the State. But it is a question to what extent this branch of the work can be kept up, owing to the great difficulties of transportation and the increasing cost of preparing and handling the exhibits.

During the past year reels showing certain phases of the work at the Marshfield Bird Farm and at the Sandwich Fish Hatcheries have been added to the collection of moving pictures.

## ENFORCEMENT OF LAWS.

### Personnel.

Sergt. Orin D. Steele and Corp. Edward A. Backus, upon returning from overseas service, resumed their duties in the department. One new appointment was made — Edward Babson of Gloucester — soon after his return from duty with the mine-laying fleet of the United States Navy in European waters during the war.

The department has met with a great loss in the passing of Deputy Allen A. David of Taunton. His heart was ever in his work, and all his thoughts were directed to the problem of how he could best serve in protecting and conserving our wild life. He had few thoughts or ambitions that did not include something to further the work. His personality had won for him a host of friends, and among these were numbered men whom, in the course of his work, he had taken to court for violations of the fish and game laws, for his was the ability to win men to see the justness of the laws which he was sworn to uphold.

### Work of the Year.

The annual conference of the Commissioners and deputies was held in February. Papers were read on various subjects, planned to bring out special phases of the work in the various districts. These papers, and the discussions which followed, dispelled misunderstandings, gave better understanding of the conditions in "the other fellow's" district, and renewed the men's enthusiasm for the work. Conditions vary considerably in the different localities, and the discussion of these local problems often gives the men new ideas and a different angle of vision on old problems. Moving pictures of the fish hatcheries and game farms were shown, visualizing the details of these activities to the men who live too far from the hatcheries to make more than an occasional short visit. The meeting gave the deputies a broader view of the conditions in the State as a whole than they could get in any other manner.

The two new Ford touring cars purchased in the spring have been of great assistance to the deputies and to the biologists, for the constantly deteriorating train and trolley service makes it very difficult to get into the outlying districts. The effect of equipping even a small part of the force with automobiles is already evident. Violators, who in past years knew the beaten lines of travel which the deputies were obliged to use, can no longer keep track of the men who, equipped with automobiles, can get into their districts at any time of the day or night; hence they are much less willing to "take a chance." Some frankly tell us that, as our men can get about so easily, they have given up illegal methods, and now want to see every one else play the game squarely. Some, going further, have agreed to report violations to the nearest deputy who has an automobile at his service, in the hope of taking the violators red-handed. More machines are needed to bring this branch of the work to the highest efficiency. In using automobiles in the work we have secured the best results by sending at least two men together; and further, in those cases (of which we have quite a number) where it comes to a question of veracity between the accused and our deputies, if corroborative testimony can be furnished, the court will more often feel justified in convicting. The motor cycle has also rendered effective service, and additional machines could be used to good advantage.

Notwithstanding the diversion of deputies for substantial periods throughout the year to work on fish distribution, fish salvage, emergency work at rearing stations, and other lines of activity outside the patrol of their districts, many court cases have been handled, the number comparing very favorably with the records of other years.

The table of court cases follows: —

*Classified Court Records, Dec. 1, 1918, to Nov. 30, 1919.*

| Violation. | Fines. | | Costs of Court. | Disposition of Case. | | | | Number of Cases. |
|---|---|---|---|---|---|---|---|---|
| | Imposed. | Paid. | | Discharged. | Convicted. | Appealed. | Filed. | |
| Aliens with firearms, | $800 | $550 | $10 | – | 19 | 5 | 4 | 19 |
| Birds: — | | | | | | | | |
| Protected at all times, | 214 | 214 | – | – | 10 | – | – | 10 |
| Partridge, closed season, | 60 | 40 | – | – | 4 | – | 1 | 4 |
| Pheasants, closed season, | 65 | 15 | – | – | 4 | – | 1 | 4 |
| Woodcock, closed season, | 20 | 20 | – | – | 4 | – | 1 | 4 |
| Waterfowl, closed season, | 40 | 40 | – | – | 4 | – | 1 | 4 |
| Game: — | | | | | | | | |
| Exposing poison for birds or animals, | 10 | 10 | – | 1 | 2 | – | 1 | 3 |
| Deer, closed season, | 85 | 40 | – | – | 4 | – | 2 | 4 |
| Deer, illegally bringing into State, | 35 | 35 | – | – | 1 | – | – | 1 |
| Rabbits, ferreting, | 20 | 20 | – | – | 2 | – | – | 2 |
| Rabbits, removing from hole, | 20 | 10 | – | – | 7 | – | – | 7 |
| Squirrels, closed season, | 30 | 30 | – | – | 3 | – | – | 3 |
| General: — | | | | | | | | |
| Hunting without license, | 438 | 428 | – | 3 | 46 | – | 11 | 49 |
| Hunting on posted land, | 35 | 35 | – | – | 7 | – | 1 | 7 |
| Hunting on State reservation, | 62 | 37 | – | – | 6 | 1 | – | 6 |
| Hunting on Lord's Day, | 138 | 128 | – | 5 | 14 | 1 | 1 | 19 |
| Hunting with motor boat, | 85 | 85 | 20 | – | 10 | – | 2 | 10 |
| Transferring hunting license, | 25 | 25 | – | – | 2 | – | – | 2 |
| Securing license by fraud, | 15 | 15 | – | – | 1 | – | – | 1 |
| Trapping with illegal traps or snares, | 35 | 35 | – | – | 2 | – | – | 2 |
| Trapping with illegal bait, | – | – | 3 | – | 1 | – | – | 1 |
| Fish: — | | | | | | | | |
| Bass, closed season, | 30 | 30 | – | – | 3 | – | – | 3 |
| Bass, short, | 4 | 4 | – | – | 1 | – | – | 1 |
| White perch, short, | 30 | 30 | 5 | – | 5 | – | 1 | 1 |
| White perch, bag limit, | 20 | 20 | – | – | 1 | – | – | 1 |
| Trout, closed season, | 8 | 8 | – | – | 4 | – | – | 4 |
| Trout, short, | 122 | 122 | – | – | 8 | – | 1 | 8 |
| Pickerel, closed season, | 10 | – | – | – | 1 | – | 1 | 1 |
| Pickerel, short, | 9 | 9 | – | – | 2 | – | – | 2 |

*Classified Court Records, Dec. 1, 1918, to Nov. 30, 1919* — Concluded.

| Violation. | Fines. | | Costs of Court. | Disposition of Case. | | | | Number of Cases. |
|---|---|---|---|---|---|---|---|---|
| | Imposed. | Paid. | | Discharged. | Convicted. | Appealed. | Filed. | |
| Lobsters: — | | | | | | | | |
| Lobsters, short, | $547 | $492 | – | 1 | 20 | 2 | 2 | 21 |
| Lobsters, egg-bearing, | 70 | 45 | – | – | 4 | – | – | 4 |
| Lobsters, interfering with pots or traps, | 60 | – | – | – | 3 | 3 | – | 3 |
| Lobsters, taking without a license, | .80 | 80 | – | 2 | 9 | – | 1 | 11 |
| Lobsters, illegally taking in Massachusetts. | 50 | 50 | – | 2 | 3 | – | – | 5 |
| Shellfish: — | | | | | | | | |
| Scallops, seed, | 240 | 130 | – | 1 | 16 | 3 | – | 17 |
| Scallops, taking without a permit, | 50 | 50 | – | – | 3 | – | 1 | 3 |
| Clams, taking without a permit, | 75 | 75 | – | 1 | 15 | – | – | 15 |
| General: — | | | | | | | | |
| Fishing in closed ponds, | 20 | 20 | – | – | 2 | – | – | 2 |
| Fishing in fresh waters other than by hook and hand line. | 20 | 20 | – | – | 2 | – | – | 2 |
| Torching, | 100 | 60 | – | – | 2 | – | – | 2 |
| Trawling, | 35 | 15 | – | 1 | 4 | 1 | – | 5 |
| Maintaining fish traps, | – | – | – | 1 | – | – | – | 1 |
| Fishing with more than ten hooks, | – | – | – | 1 | – | – | – | 1 |
| Total, | $3,812 | $3,072 | $38 | 19 | 261 | 16 | 33 | 275 |

*Summary.*

| | |
|---|---|
| Number of cases, | 275 |
| Fines imposed, | $3,812 |
| Fines paid to Nov. 30, 1919, | $3,072 |
| Costs of court paid to Nov. 30, 1919, | 38 |
| Cases discharged, | 19 |
| Cases convicted, | 261 |
| Cases appealed, | 16 |
| Cases filed, | 33 |
| Number of laws violated, | 43 |

Among those brought to account this year were some who have been persistent violators, and who were convicted of flagrant violations of law. Typical of these are the following cases: —

Romolo Adrower of Winthrop, Mass., a naturalized Italian, who was apprehended by Deputy James E. Bemis at Ashland on October 22, with 4 robins and 1 fox sparrow in possession.

His Honor Judge Willis A. Kingsbury of the Framingham court fined this man $50, which was paid. Henry Yanaco of Boston was apprehended on October 13 in Ashland by Deputies James E. Bemis, Jay Snell and Elmer A. Macker, and was found to have 7 robins and 4 vesper sparrows in his possession. In this case Judge Kingsbury imposed a fine of $25. Upon complaint of Deputy Thomas L. Burney for the illegal killing of a pheasant on September 21, Judge Henry T. Lummus of Saugus fined Lewis Goldani of Boston $50.

Leon E. James was taken by Deputy Dennis F. Shea in the act of killing a wood duck (protected at all times in this and in almost every other State in the Union, as well as by the Federal law), and Judge Henry C. Davis of Ware imposed a fine of $10, which was paid. Walter K. Chapman of Ipswich was arrested on September 9 by Deputy Edward E. Babson for killing a black duck before the season opened, and Hiram N. Currier of Beverly was taken by Deputies Carl E. Grant and Edward Babson for shooting black ducks on February 22, over a month after the season closed, a violation of the Federal as well as of the State law.

Horace E. Elliott of Beverly was arrested by Deputy Carl E. Grant and Edward Babson, and was convicted on April 16 for placing poisoned baits for killing foxes. Judge Geo. B. Sears of Salem imposed a fine of $10 for this offence. This amount is too small, as the price of one fox pelt will pay this fine twice over. In addition to this fine the defendant paid over $75 to the owners of five dogs that had been killed by picking up the baits which he admitted having put out.

The law pertaining to deer gives them but small protection. On only an occasional case can sufficient evidence be secured to convict a person for taking deer out of season, but on November 7 Deputy James E. Bemis and Mr. Charles W. MacNear, a deputy serving without compensation, brought Robert L. Hebden of Ashland before Judge Kingsbury at Framingham for killing a deer in closed season, and he was fined $75. Much credit in this case is due to Mr. MacNear, who was in a position to get full information and to point out the guilty party.

Robert Cushman of Duxbury was taken before the court by Deputy Charles E. Tribou, charged with the possession of 21

uncooked lobsters less than 9 inches long. Some were as small as $6\frac{1}{4}$ inches. A fine of $63 was imposed, which was paid. On September 13 the John Nagle Company, dealers in lobsters at the Fish Pier, South Boston, was charged by Deputies F. W. Goodwin and Edward E. Babson with selling 48 uncooked lobsters less than 9 inches long. A fine of $96 was imposed by Judge Edward L. Logan in the South Boston court.

Deputy William H. Seaman, assisted by Messrs. W. A. Pierce and Edward F. Bowen, found Joseph Bourque fishing with more than 10 hooks in Emery Pond, Raynham. Judge W. S. Woods of Taunton found him guilty and imposed a fine of $20. He was using 26 floats with hooks attached. On June 5 Fred W. Bridges of Holyoke was taken in Plainfield by Deputy L. E. Ruberg with 27 short trout in his possession. Although he was charged with the possession of only 3 of the above number, Judge John B. O'Donnell of Northampton imposed a fine of $50. It may be mentioned that this type of violation is getting less common.

Considerable trouble has been experienced by certain deputies through the illegal taking of scallops from the waters of Buzzards Bay. With the assistance of Messrs. Walter K. Perry and Paul Blankinship, and others interested in the preservation of this valuable fishery, Deputies S. J. Lowe and W. H. Seaman last January brought Albert Bessette before Judge James P. Doran at New Bedford for taking "seed" scallops. "Seed" scallops are those which have not reached the age of reproduction and on which the future scallop fishery depends. A fine of $25 was imposed. On September 10 Arthur Bessette, brother of the above defendant, was before Judge Bert J. Allen of Wareham on complaint of Mr. Blankinship for a similar offence, and was fined $25. Louis Baillargeon of Fairhaven was arrested by Messrs. Perry and Blankinship at Mattapoisett, and paid a fine of $25 on conviction before Judge Nathan Washburn at Wareham. He was charged with opening seed scallops in a boat. This was done to destroy the evidence, as, if landed, the size of the scallops would have proclaimed them to be illegal. Messrs. Perry and Blankinship, who assisted in the foregoing cases, are deputies serving without compensation.

It was reported to this department early last year that George H. Cummings of Shrewsbury, an unpaid deputy, had been guilty not only of conduct unbecoming an officer, but of direct violations of the law. Inquiry discovered witnesses who claimed that Mr. Cummings had accepted a bribe to refrain from bringing to court a case where short pickerel had been taken, and the case in question had never been presented to court. In several other instances he had accepted amounts equal to the fines which might have been imposed, and had kept the cases out of court. Deputy Jay Snell of the regular force placed this man before Judge Samuel Utley of the lower court on April 5. He was tried in the Superior Court on May 29 by Judge Joseph O'Connell of Worcester and fined $100.

During the year 40 hunting licenses were revoked, and the city or town clerk notified, in accordance with the law, that the holders would not be entitled to another certificate for a period of one year from the date of conviction.

Hunting by aliens is one of the most frequent violations. Conviction for this offence carries with it forfeiture of firearms. Fifty such forfeited guns and rifles were sold during the year in accordance with the provisions of the law, and the proceeds turned into the treasury of the Commonwealth. These firearms are of the lowest grade in almost every instance, and bring but a small price. Some turned over to us were in such condition that they were as dangerous to the hunter as to the quarry. A small caliber gun, taken from a man in the woods, had a twist in the barrel, and if discharged would probably have exploded. Alien hunters go afield with the intention of throwing away the gun if apprehended, and consequently use cheap guns so that the loss will not be so great. That this and not lack of money is the real reason for use of cheap guns is borne out by the fact that our court records show that in almost every instance the $50 fine is paid on the spot.

Concerted drives by squads of deputies in automobiles, directed against the violators of the lobster laws, inaugurated last year with such satisfactory results, were continued this year and kept up pretty continuously through the lobster fishing season. Forty-four cases were brought into court and $807 in fines imposed, of which $667 was paid. An interesting case is that of

E. S. Publicover of Duxbury, convicted of having short lobsters in possession. Mr. Publicover made the statement before Judge Harry B. Davis of the third Plymouth District Court that if the sentence in this case were suspended, he believed he could induce the lobster fishermen of that locality to form an association. Judge Davis accepted his proposition, taking pains to explain to Mr. Publicover and to the local lobster fishermen that he was opposed to the practice of dealing in short lobsters, and that he would impose increasingly heavy fines in all cases brought before him for this offence. He expressed his willingness to attend a meeting of the lobstermen and explain his views on the subject, in the hope that they would form an association and realize the benefits to be derived from observing the laws. A meeting of the lobster fishermen was arranged by our Board, and was held on November 12, in Ocean Hall, Brant Rock. Judge Davis came before the men and gave them a very stirring talk. A member of the Board and the district deputies were present, and representatives of other associations. We take this occasion to commend the public service of Judge Davis in this connection, and we believe that the results will be far-reaching in that locality. When such an association is formed in a community where the word has always been "to go and get all there is to be had, and take a chance on getting by," we find that it bears fruit within a short time, and the fishermen reap the benefit of increased catches of legal lobsters.

There is a real need for the development of a corps of trained fish messengers, one for each hatchery, to relieve the district deputies of the responsibility for this branch of the work, and to give them the opportunity to care for their districts without interruption. One of our district deputies has traveled a distance of 17,000 miles this season in fish distribution. There are many persistent violators who can never be apprehended unless our men are free to follow them up at the time when something is going on. At present it frequently happens that, when conditions are about right for securing conclusive evidence which would bring a conviction, a deputy may receive notice to deliver a shipment of fish, with the result that by the time he returns and tries to pick up the trail again the opportunity is past.

We have noted that during the past year more stringent regulations concerning deer have been put into effect in some of the near-by States. This is the result of fifteen cases brought before the courts of this State and the Federal courts last year for violation of interstate commerce regulations in the shipment and sale of game. Deputies F. W. Goodwin and Carl E. Grant aided the Federal officers materially in the prosecution of the cases before the Federal courts. The persons concerned have discontinued this traffic to a great extent, and the convictions have had a deterrent effect on others who might have been tempted to do likewise.

Our work is still hindered by the lack of a proper boat for enforcing the laws along shore, particularly those in regard to lobsters, torching and seining by alien fishermen, and the hunting of migratory water fowl on the Lord's Day. At some seasons of the year practically the whole length of the coast from Newburyport to Westport needs to be patrolled. It is next to impossible to hire a boat for law-enforcement work except at a very high rate, and unless the owner is guaranteed against any damage to the boat, for there is a general fear on the part of boat or automobile owners that by letting us use their boats or cars they will incur the enmity of the persons convicted. The value of a fast boat was demonstrated this fall, when a public-spirited citizen loaned a swift boat to our Deputy Orin D. Steele for use in Boston Harbor. In three days' time violators were apprehended and substantial fines paid, exceeding the expense of the boat and the deputies. Still better, word was circulated that the Commission had the upper hand of the situation, and those who otherwise would have taken chances abandoned their methods. This, we notice, is apt to be the case wherever our men have demonstrated that they are masters of the situation.

## New Legislation, Session of 1919.

The General Court of 1919 enacted fifteen laws relating to fisheries and game.

Chapter 8, General, prohibits the taking of alewives for five years in the Weweantit River.

Chapter 33, General, makes it lawful to spear eels and carp.

These species are of practically no value for food. They suck from the bottom of ponds the material on which fish feed, and undoubtedly take in the eggs of other valuable fish. It has been found that where the carp are plentiful in our local waters the other fish are very scarce, and the people who originally introduced them now recognize the unwisdom of having done so.

Chapter 39, General, extends the time in which the Commissioners may lease Tisbury Great Pond.

Chapter 40, General, establishes a close season on quail, until 1922, in Essex, Dukes and Nantucket counties. The almost total extinction of the quail in these localities makes such action necessary.

Chapter 57, General, authorizes the Fish and Game Commission to permit the taking of smelt in inland waters, subject to rules and regulations to be approved by the Governor and Council.

Chapter 65, General, extends to all wild birds and quadrupeds the protection formerly accorded to game birds only, against trapping, snaring, netting, pursuit by power boat or taking by swivel or pivot gun.

Chapter 66, General, establishes a close season on raccoons from January 1 to September 30.

Chapter 83, General, increases the penalty for taking wild birds and animals by illegal methods.

Chapter 153, General, changes the open seasons on ruffed grouse, woodcock, quail and gray squirrels from the month of November to October 20 to November 20; establishes the open season on hares and rabbits from October 20 to February 28; and further, provides a close season on ruffed grouse until Oct. 20, 1920.

Chapter 200, General, provides a bounty on seals. Seals have multiplied undisturbed since the repeal in 1908 of chapter 139 of the Revised Laws. They destroy such quantities of fish as to make extermination desirable.

Chapter 296, General, requires that persons be licensed to fish in all inland waters of the Commonwealth which have been stocked by the Fish and Game Commission since Jan. 1, 1910. The provisions and purposes of this act are fully discussed in the section of this report on "Inland Fisheries."

Chapter 334, General, permits this Board to make rules and regulations governing the taking and sale of seed and adult scallops in certain instances.

Chapter 351, General, creates the office of inspector of fish, and provides for the regulation of the sale and storage of fresh food fish.

Chapter 73, Special, revokes certain rights formerly held by Alexander K. Crocker for taking alewives from Mill River, Sandwich.

Chapter 201, Special, authorizes the Board of Commissioners on Fisheries and Game to lease Bartlett's Marsh Pond and White Island Pond, Wareham, for the artificial propagation of alewives.

## Recommendations for Legislation.

The Board of Commissioners on Fisheries and Game respectfully recommends the passage of laws designed to accomplish the following purposes: —

1. To allow the Commissioner of Conservation to make rules and regulations to control the taking of salmon.

The Commissioners believe that the taking of salmon may be best regulated by rules and regulations as the conditions may indicate changes needed, and the matter of seasons, etc., can best be regulated in this manner.

2. To extend the close season on black bass and establish a catch limit thereon.

Many fishermen do not use judgment in this regard, and in the excitement of catching bass take more fish than they need or can use. Others make a business of fishing for market, and some bag limit is necessary to conserve our bass supply. The close season during the winter is asked to conserve the bass for the next breeding season.

3. To stop the sale of pickerel and establish a catch limit thereon.

This is imperative because market fishermen are rapidly killing out the breeding fish in many of our great ponds, and they must be checked if we are to continue to have pickerel.

4. To establish a catch limit on horned pout and yellow perch, and establish a close season on horned pout.

Our waters are being sadly depleted by many heedless fishermen, and unless the small fish are given a chance to reproduce they will soon be killed out. Horned pouts care for their young, and if the adults are taken during the breeding season many schools of small fish are lost.

5. To allow the Commissioner of Conservation to screen certain ponds and streams.

Many times it seems as if all efforts to stock certain waters are without result. Many species of fish adapted to pond life are salt-water seeking at certain times of the year, and will leave ponds and rivers if not retained by screens, which many times may be erected at a small cost, and conserve large quantities of small fish at flood times.

6. To repeal chapter 312 of the General Acts of 1917 and chapter 212 of the General Acts of 1918 (concerning the licensing of lobster fishermen), and enact a new law carrying the essential features of the above acts, and annulling certain inconsistencies and adding new sections to make it more consistent with the needs of the fishermen.

This is in conformity with the suggestions of deputies and fishermen after having given it two years' trial.

7. To correct an unintentional error in chapter 20 of the General Acts of 1917, which is for the protection of wild or undomesticated birds.

In this act the words "or having in possession" were omitted in the first line. These words are very necessary to the proper enforcement of this act, as a person seen coming from the woods with one of these protected birds would not be liable unless it could be proven (often times difficult to do) that he had "taken or killed" the bird.

8. To extend the close season on ruffed grouse.

The breeding season of ruffed grouse in 1919 seems to have been fairly good, and more birds are in our covers, but we do not think that the danger point has been more than temporarily covered, and that a longer period of protection is needed. Birds which are legally taken in other

States and countries, and are the property of hunters who have legally taken them, should be allowed to be brought in if not in violation of the laws of the States whence they came. Five days should be allowed to come from some of the back woods of Maine and New Brunswick.

9. To allow the sale of the skin and body of raccoons and other fur-bearing animals.

As the law does not seem to be clear about the sale and possession of the bodies and skins of raccoons and other fur-bearing animals, this new law is necessary to definitely state that they could be taken and sold legally. The principal object of the law was primarily to be sure that the fur was in prime condition, and to insure better pelts and prices.

10. To prohibit cats on certain areas which are noted as breeding grounds for birds.

The law relative to cats on the island of Muskeget has been very beneficial to the summer bird colonies, and the further extension of this law is asked to cover other islands that are especially noted for bird colonies. It will be a hardship on no one to order that cats shall not be taken onto these areas.

11. To dispose of certain property not at the present time used by the department.

The Adams Hatchery was established under chapter 60 of the Resolves of 1898, and had been used until the winter of 1918. The results have been poor compared with other stations, and the water supply is inadequate and cannot be supplemented. Fish hatched at this station are not strong, fry cannot be kept for a reasonable length of time after hatching, and the hatchery is too expensive to maintain for the amount of fish which are reared. We consider that it is not an economical proposition to try to continue this station.

12. To clarify the provisions of section 8 of chapter 296 of the General Acts of 1919, which has confused both the clerks and the deputies as to the meaning and scope of this section.

A more concise wording must be given so that there will be no confusion or misinterpretation as to who is entitled to a trapping license. A fee is necessary to compensate the town and city clerks for their work in issuing these trapping certificates.

13. To shorten the open season and place a bag limit on rabbits and hares.

This is necessary so that our hares and rabbits will not be exterminated.

14. To provide for exhibitions and other means of interesting and educating the public in the conservation and propagation of birds, fish and game in the Commonwealth, $2,000.

The publicity work conducted for several years past has been productive of results which make it very desirable that this line of endeavor be continued.

15. To provide for investigation and preliminary plans for the establishment of a salt-water fish hatchery, $2,000.

This Commonwealth has off its shores one of the most valuable coastal fisheries of any State in the Union. It has been demonstrated that certain species of salt-water fish which frequent our shores can be successfully propagated. In order to maintain and increase the present supply, eventually the State should own and operate a fully equipped, large-sized hatchery for propagating these species.

16. To provide for additions and replacements to the buildings and equipment of the hatcheries and game farms under the control of the department.

### Montague Rearing Station.

*Road, $200; Fence, $200; Construction of Additional Rearing Pools, $2,500.* — The road is a new one, running over soft ground. To put it in condition to stand the heavy teaming necessitated by the work, the sum asked will be necessary. A fence is needed to keep out stock grazing on the land, and to better control visitors, to whom no opportunity should be given to go near the pipe valves regulating the water system. More rearing pools are needed to increase the capacity of the plant and utilize it to the limit.

### Amherst Rearing Station.

*Enlarging Water-supply Pond and Construction of Additional Rearing Pools, $1,000; Road, $200; Fence, $200; Purchase of Land, $375.* — The enlargement of the water-supply pond and construction of additional rearing pools is necessary in the development of the station. The same reasons which make road and fence necessary at Montague Rearing

Station apply also at Amherst. The land on which the work is carried on is now held under lease with option of purchase, which expires in June, 1920. The sum asked for is for taking up the option.

### Palmer Hatchery.

*Building, $4,000; Additional Rearing Pools, $3,000; Extension of Pipe Line, $150; Repairs to Tenement House, $800.* — A building is necessary to house a large and a small truck. A second story would provide for the storage of fish cans, special screens used in bass culture, gear for use in salvage work, tools and other bulky equipment. Additional rearing pools are needed for salmon, trout, horned pout and perch culture, as well as bass. The pipe line should be extended from the superintendent's house to the tenement house, and certain much-needed repairs made on the latter.

### Sandwich Fish Hatcheries.

#### *Sandwich Station.*

*Cement Head Trough for Nursery Ponds, $300; Driven Wells, $100; Fence, $750.* — The wooden head trough has been in use for a number of years, and is now in a state of decay, making it imperative that it be replaced. Should it give way at any time, through lack of repair, the loss of all the fish in the hatchery might easily follow. Twelve additional driven wells to supplement the water supply would add to the efficiency of the hatchery; and a portion of the station grounds along the State highway should be fenced off.

#### *East Sandwich Station.*

*Six Cement Ponds, $2,500; Building, $4,000; Erlargement of Stripping House, $1,500; Three Nursery Ponds, $500; Six Driven Wells, $100; Road, $750; Purchase of Land, $75.* — The six cement ponds are needed to replace ponds of wooden construction, which are now so rotted as to be dangerous to the fish in the ponds, and of limited rearing capacity. A building is needed which will house a large and a small truck, with a second story for the storage of fish cans, special gear used in salvage work, tools and other bulky equipment. The house in which stripping of fish is done should be enlarged, and equipped with batteries for the hatching of perch, smelt and alewife eggs. In the development of the station three additional nursery ponds for rearing fingerling trout, and six additional driven wells, are needed. A road should be constructed from the main road around the pools and back to the main road by way of the office building. A portion of the land included in the East Sandwich Station is now held under lease, with option of purchase which expires in 1920. It is desired to add this land to that already owned here by the State.

### Sutton Hatchery.

*Reconstruction of Rearing Pools, $2,000; Reconstruction of Hatchery Building, $3,000; Grading, Drainage, etc., $500.* — It is very desirable that the rearing pools be reconstructed to eliminate much wooden construction which has rotted out and cannot be repaired, thus increasing the rearing capacity of the water supply. The hatchery building is in a very dilapidated condition. The sills have rotted away, and in its present condition it is unfit for use. An appropriation is needed for rebuilding it. In connection with the work of making this over into a rearing station considerable work needs to be done in grading, drainage and the removal of discarded pens formerly used in bird rearing.

### Marshfield Bird Farm.

*House, $500; Additional Coops and Yards, $500; replacing Floors in Brooder House, $500; Purchase of Land, $2,500.* — There is no place at present where grain can be stored, and a proper place is an absolute necessity to prevent spoilage. Additional coops and yards are needed for taking care of the brood and adult stock, owing to the extensions which have been made in the rearing activities, and with a view to enlarging the work of hatching and rearing pheasants. The floors in the brooder house have been so thoroughly riddled by rats as to make it unsafe to keep birds there, and cement floors should be put in. The land on which the bird farm is located is held under lease, with option of purchase expiring in 1920. It is desired to purchase this land for a permanent bird farm.

### Sandwich Bird Farm.

*Additional Coops and Houses, $1,000; Building, $1,500; Purchase of Land, $1,700.* — These coops and houses are needed for better housing the stock. There is no place now where materials can be stored except a very small shed, which is wholly inadequate for caring for the grain, tools, shipping crates and other equipment which is in constant use. A proper building should be provided, with a workshop where coops, etc., could be built and repair work done. The lease on a portion of the land on which the bird work is carried on expires, as does the option of purchase, in 1920, and it is desired to take up the option at the proper time.

### Wilbraham Game Farm.

*Repairs on Superintendent's House, $500; Repairs on Tenement House, $300; Completion of Camp, $200; replacing Fences, etc., $1,000.* — Both the superintendent's house and the tenement house require repairs to make them comfortable for the occupants. The partly completed camp on the

grounds should be finished for use, during rearing season, of the man in charge of the stock. Considerable replacement work is needed during the coming year of worn-out wire fences, bird runs and pens.

## Marthas Vineyard Reservation.

*Repairs on Barn, $300; Storage House, $100; Work on Superintendent's House, $250; Shed, $500; Reforestation Work, $300; Fire Stops, $2,500.* — The barn on the reservation is no longer safe, and the repairs which have been required for some time should be no longer delayed. The floor needs to be replaced, foundations relaid, windows replaced and portions of the wall rebuilt. This building is used, not only for the housing of tools, hay and stock, but for the automobile as well. A small building near the house, designed for office and workshop, but never completed, could by a small outlay be used to good advantage. A porch is needed on the superintendent's house for the comfort of the occupants. There is no porch or piazza whatever at present. The shed asked for is for the storage of farm implements and general storage purposes. Reforestation work on this area should be continued. There is a substantial portion of the land suitable for reforestation, which would add to its value as a bird sanctuary by providing wintering cover for the birds, as well as a cleaner forest floor for breeding and feeding purposes. The main object of the reservation is the preservation of the heath hen, and the greatest danger to be guarded against are the fires which in the past have swept its covers at intervals. The fire stops broken out in past years should be plowed out and extended. In their present condition they would not perform their function in case a fire should start.

## BIOLOGICAL DEPARTMENT.

The biological work, which has been at a standstill owing to the fact that the biologist, Dr. David L. Belding, and his laboratory assistant, Mr. Leslie J. Gilbride, were in the service during the war, was actively resumed upon the return of Dr. Belding in May. As the results of the work on various lines have been set forth in appropriate places throughout the report, only brief mention is made here of the ground covered.

Mr. James A. Kitson entered the service as assistant biologist in May, 1919. His chief duty will be to conduct field investigations. Mr. Gilbride resumed his position as laboratory assistant in September, 1919.

As in the past, no laboratory facilities were available at the State House, and the former quarters at the Evans Memorial Hospital were unobtainable. Without funds for renting outside quarters the necessary laboratory work has been conducted in quarters supplied by friends of the biologist, and by means of a portable laboratory. The rear compartment of a five-passenger Ford car was fitted with two strongly built trunks, one resting between the seats, the other upon the seat. These trunks contain compartments for essential laboratory apparatus. Thus a useful laboratory can be quickly set up for use in any part of the State, proving of special advantage in field work. It is hoped that quarters for a permanent laboratory may be available in the ensuing year, as the nature of the proposed work emphatically demands permanent quarters, as well as a portable laboratory.

Much of the time of the biologist is taken up in routine matters, — answering numerous inquiries and letters, identifying specimens, examination of ponds, streams or coastal waters, determining the cause of death of fish and game at the hatcheries or bird farms, and any other special matters which should be investigated from a biological standpoint.

A survey of the present condition of the alewife fisheries in all of the coastal streams was completed. Likewise our experiments were continued in connection with the breeding of ale-

wives, which is more fully set forth in connection with the work of the Sandwich Fish Hatcheries.

In the installation of fishways it is very essential to have the biological problems studied before any construction work is started, in order to be sure that, given the mechanical arrangement by which to ascend the stream, the fish will not be held back by such other considerations as pollution and disturbance of spawning grounds. The run of fish must be followed, the spawning habits studied, and likewise the period when the mature fish return to the sea and the time when the young alewives go back. It is only by conducting these field investigations that the data can be compiled for future improvements in the work.

Comparatively little work has been done in connection with the important subject of fish and bird diseases. The most interesting specimen this year was a fibroid tumor from the peritoneal cavity of a white perch taken from Waban Lake, Wellesley. Substantial progress has been made in collecting available information on fish and bird diseases and collating it for reference in further studies of these subjects.

Very often a large amount of time is devoted to the working out of the details of a plan which may not be put into operation until the following year or years. This is true of the subject of pollution this year. Much time was given to a study of the subject, with a view to establishing a plan upon which this work can be more effectively followed in the future. Some action was taken in reference to individual cases of pollution, as more fully set forth under that subject.

A standard method of recording pond and stream surveys has been perfected during the year and adopted for use in the States of Massachusetts, New Jersey and New York in a meeting of representatives from the commissions of those States held at Hackettstown, N. J., in November, 1919.

## WILD BIRDS AND ANIMALS.

### Breeding Season.

The remarkably mild winter which obtained over the whole State assisted greatly in insuring high vitality in the brood stock, both in animals and birds. With certain local exceptions the conditions during the breeding season were exceptionally favorable to all wild life.

### Forest Fires.

The number of forest, brush and grass fires was smaller, and the total area burned over considerably less than for the last few years, due to a certain extent to the large amount of rainfall. Not many large tracts were burned over, the most extensive being 1,300 acres in North Attleborough on May 29, and 1,500 acres in Gloucester on August 12. This can be a source of serious injury to wild life, for a fire in the nesting areas during breeding time will mean a large loss of eggs, young, and, to some extent, adult birds. This evil has been greatly minimized in recent years by the equipment of towns with motor fire apparatus, the more general use of the telephone, and the increasing efficiency of the State forest fire service.

### Posted Land.

We believe that a better understanding is coming to exist between the sportsmen and fishermen of the Commonwealth and the owners of the land. The solution of this problem lies very largely in the hands of the sportsmen and fishermen themselves. It will never be solved until the citizen who goes onto the land of another will respect the property rights of the owner, and will treat the land and the fences, the gates, building and other equipment thereon with the same care and consideration that he would use if the property were his own. The development of this sense of responsibility and accountability in the mind of every sportsman and fisherman is the first requisite.

## Effect of the War on Hunting.

The question occurred to us over a year ago as to what would be the effect of military training on the young men of the country in the way of stimulating a larger interest in the use of firearms and in the outdoor sports of hunting and fishing. We have looked into the records of the civil war in vain for any enlightenment on this point. It is true that at the end of the war there was a vast new country west of the Mississippi River which appealed to numbers of adventurous young men, and many of them migrated to it. On the other hand, there is nothing to show that greater numbers took up the sports who had not prior to the war been interested in firearms as a sporting proposition.

We have been especially interested this year to see what would be revealed in the number of hunting licenses issued as compared to a similar period last year. We find that during the period Jan. 1, to Nov. 30, 1918, 58,529 hunting licenses were issued, and during the same period for 1919, 73,480, showing an increase of 25 per cent.

The figures of the actual number of hunting licenses issued in certain representative towns and cities in each county for three years past are interesting: —

*Comparative Table of Hunters' Licenses issued during the Years 1917, 1918 and 1919.*

| | Jan. 1 to Nov. 30, 1917. | Jan. 1 to Nov. 30, 1918. | Jan. 1 to Nov. 30, 1919. |
|---|---|---|---|
| Barnstable County: — | | | |
| Barnstable, | 328 | 129 | 378 |
| Falmouth, | 261 | 275 | 272 |
| Berkshire County: — | | | |
| Pittsfield, | 1,045 | 1,062 | 1,079 |
| North Adams, | 549 | 576 | 642 |
| Bristol County: — | | | |
| Taunton, | 596 | 627 | 804 |
| New Bedford, | 725 | 843 | 1,186 |
| Fall River, | 551 | 514 | 671 |
| Dukes County: — | | | |
| Edgartown, | 121 | 103 | 97 |
| Tisbury, | 113 | 113 | 136 |

*Comparative Table of Hunters' Licenses issued during the Years 1917, 1918 and 1919* — Concluded.

| | Jan. 1 to Nov. 30, 1917. | Jan. 1 to Nov. 30, 1918. | Jan. 1 to Nov. 30, 1919. |
|---|---|---|---|
| Essex County: — | | | |
| Lawrence, | 587 | 573 | 677 |
| Gloucester, | 410 | 442 | 478 |
| Lynn, | 639 | 609 | 767 |
| Franklin County: — | | | |
| Greenfield, | 639 | 672 | 770 |
| Hampden County: — | | | |
| Springfield, | 1,715 | 1,807 | 2,191 |
| Holyoke, | 649 | 612 | 698 |
| Hampshire County: — | | | |
| Northampton, | 631 | 591 | 700 |
| Ware, | 267 | 256 | 252 |
| Middlesex County: — | | | |
| Lowell, | 921 | 772 | 925 |
| Marlborough, | 309 | 312 | 337 |
| Nantucket County: — | | | |
| Nantucket, | 180 | 158 | 222 |
| Norfolk County: — | | | |
| Quincy, | 375 | 431 | 574 |
| Dedham, | 197 | 175 | 222 |
| Plymouth County: — | | | |
| Plymouth, | 511 | 560 | 628 |
| Brockton, | 801 | 830 | 1,050 |
| Suffolk County: — | | | |
| Boston, | 2,819 | 2,795 | 3,700 |
| Revere, | 168 | 181 | 204 |
| Worcester County: — | | | |
| Worcester, | 2,529 | 2,422 | 2,793 |
| Fitchburg, | 890 | 886 | 972 |
| | 19,526 | 19,326 | 23,425 |

The figures indicate that we were reasonably accurate in our surmise that at the close of the war a great many men who before had led sedentary lives would turn to the outdoors for recreation. All of this will mean a greater drain on the wild-life resources of the State, which must be met by increased artificial propagation, and, in some cases, increased restrictions in the taking. We believe that the time has gone by when any form of wild life in this State can stand an annual open season of four and one-half months, as is the case to-day, for example, with respect to rabbits.

## Migratory Birds.

### *Song and Insectivorous Birds.*

A survey of conditions throughout the State, based on observations of the district deputies, shows that the song and insectivorous birds are either on the increase or holding their own. This is especially true of the central section.

As a whole, the conditions in the spring were favorable, with the exception that on March 27 there was a blizzard in the western part of the State during which, and in the week following when drifts were 6 to 12 feet high, hundreds of bluebirds, robins, ground sparrows and other small birds perished.

Many species which frequent Marthas Vineyard are becoming more numerous. Here, as also throughout the State generally, many people are taking an interest in the welfare of the birds, and have set up feeding boxes, planted food, and fed the birds in the severe weather. The schools, too, have helped by teaching the economic importance of birds, and egg-collecting is getting to be a thing of the past. On Nantucket they are maintaining their numbers, and the meadow lark, which was hard hit by the winter of 1918, is regaining lost ground.

Mr. F. Seymour Hersey mentions the breeding of the slate-colored Junco at Taunton as the outstanding feature of the season from a scientific standpoint. It breeds regularly north of Massachusetts and to some extent in the higher parts of the western portion of the State.

*Ornithological Conference.* — For a considerable period of years past the Board, both under the present organization and under its predecessors, followed a conservative policy in granting permits for the collecting of birds and eggs for scientific purposes, feeling that the number of specimens taken should be kept to the minimum. With the passage of the enabling act of 1918, which put the so-called migratory bird law into operation, began the issuance of permits by the Biological Survey for the taking and possession of migratory birds and their eggs for scientific and for propagating purposes. There were several forms of permits: —

1. To take, possess, buy, sell and transport migratory birds, their nests and eggs, for scientific purposes.
2. To possess, buy, sell and transport migratory birds, their nests and eggs, for scientific purposes.
3. To take, possess, buy, sell and transport migratory water fowl and their eggs for propagating purposes.
4. To possess, buy, sell and transport migratory water fowl and their eggs for propagating purposes, and to sell and transport their carcasses for food purposes.

These Federal permits, however, are not valid until a corresponding permit has been issued by the State in which the holder intends to operate.

This brought up, with pressing insistence, the question of what policy should be followed in regard to the issuance of scientific permits in this State in the future, for an increase in the number of applications for permits to collect in Massachusetts was immediately noticed. It was apparent that there was a considerable difference of opinion, among the various persons interested in bird problems, as to whether a liberal or a conservative policy in granting collecting privileges should be followed, one side advocating, as the Commission had done, that the killing of birds should be carefully restricted, and the other side contending that the study of ornithology required the taking of specimens, and that the interests of science could be safely served without undue injury to bird life.

The question of how to handle the applications from taxidermists, to collect protected birds for the purposes of sale, came up in acute form at this time, owing to the fact that the Biological Survey had issued such permits, and applications for State sanction were being received.

The time seemed ripe for the various parties in interest to get together for an exchange of ideas and to find out what, in the opinion of the best sentiment of the State, was the proper course to pursue. Accordingly the Board set February 25 as a date for such a conference, and invited the officials of the National and State Audubon Societies, the officials of the Biological Survey, the State Ornithologist, representatives from the Boston Society of Natural History and various museums, the Commissioner of the New York Conservation Commission, the holders

of ornithological permits, and persons who have been active in the interest of bird life in various ways. Invitations were also sent to the best-known taxidermists in the State.

Chairman Adams opened the meeting by explaining its purpose, and saying that the Board had not come with any hard and fast ideas, but was there to receive enlightenment, as it wished to approach the matter in the way that would give the largest possible results for the cause. He asked that persons having any difference of view would state it frankly, and called on Dr. E. W. Nelson of the Biological Survey to begin by explaining how far the Federal government planned to go in granting permits, both for scientific purposes and for taxidermists.

Dr. Nelson stated that the Federal permits are really controlled by State action, inasmuch as they are ineffective unless backed up by a State permit. If there were no State laws, however, permits would be given to every one desiring to collect specimens for scientific purposes whose interest he considered would warrant it. This would include any young man of sixteen or eighteen years who appeared to have a sufficiently serious interest in the study of birds to make it probable that he had in him the making of an ornithologist; for to hamper deserving young men is to put the extinguisher on the future development of ornithology in this country. It is his opinion that it is necessary for students of birds to have actual specimens, and collections are not always available to them. A scientific collector, taking pride in his specimens, which are easily destroyed, would hesitate to permit them to be freely used by inexperienced young students. He went on to say that, reviewing in his mind the list of men who have made a study of ornithology in the United States, he did not recall a single man who would have been an ornithologist if his interest had not first been stimulated by the knowledge gained in taking specimens. He had discussed this point with Mr. William Brewster and some eight or ten other ornithologists, and they had agreed without exception that to stop young ornithologists from collecting would practically end scientific ornithology in this country. He recommended care, however, and did not favor the indiscriminate issuance of licenses, for in some cases

such privileges have been abused. As a case in point he mentioned the experience of Texas, where, under such permits, game was killed out of season to such an extent, and so outraged the feeling of the people, that at the next meeting of the Legislature the law authorizing the issuance of scientific licenses was repealed. It is for the issuing authorities to see that only the really deserving receive permits.

He illustrated the necessity of encouraging young students by recalling the history of ornithology in this country. In Massachusetts in the early days and until the 70's there were few game laws, and these were practically dead letters and rarely enforced up to 1885. Along in the late 70's some young fellows in Cambridge — William Brewster, H. W. Henshaw and others — became interested in birds. They began to collect, and this group gradually developed into the Nuttall Ornithological Club. The interest spread from Massachusetts to other parts of the country, and resulted in the formation of the National American Ornithologists' Union. One of the first acts of this organization was to form a committee on bird protection, and another on bird distribution and migration. The committee on bird protection, in the course of a few years, developed into the National Association of Audubon Societies. Dr. C. Hart Merriam was made chairman of the committee on distribution, and as the work grew he took it on to Washington, secured a Federal appropriation of $5,000 a year to carry it on, and developed the work into the organization now known as the Bureau of Biological Survey. Probably no one would dispute the claim that the work of the Audubon Society and the Biological Survey has been very largely responsible for the development of bird conservation in the United States. Thus those sixteen-year-old boys in Cambridge were the fathers of the present bird laws and of the sentiment for game conservation which has grown so tremendously in this country. To-day the United States is a leader in the world movement for the conservation of wild life. Canada is working with us, and just before the war started a Russian official visited the Biological Survey to learn how wildlife conservation was conducted in this country. Australia, New Zealand, South Africa and Japan have likewise come to us for suggestions. This bit of history seems sufficient to show that

young men who have the proper spirit and proper desire for the serious study of ornithology should be helped to develop.

On the question of how the taxidermist should be handled, Dr. Nelson admitted that the problem was more difficult, and that the taxidermist's activities should be restricted in some way, and that permits to collect commercially on a wholesale scale should not be given. But the taxidermist is nevertheless necessary to properly preserve specimens, and there is no objection to mounting birds killed in open season. Neither did he think that a reasonable amount of commercial collecting should be prevented, since without this, study specimens for schools, and in many cases for scientific investigations, could not be obtained. The Massachusetts Commission has always granted special permits for the preservation of specimens accidentally killed in close season by storms, striking against wires, etc. It was Dr. Nelson's opinion that in such cases the birds should be mounted at the discretion of the Commissioners. He explained that the Federal taxidermist permits are in two forms, — one giving the privilege of receiving and handling the material without the right to collect, the other carrying permission to collect. The issuance of the latter class would be more limited than the former.

Very interesting discussions followed, of which only the general trend can be given.

It was interesting to note that all the ornithologists present testified to having begun collecting at a very early age. They agreed that if their interest had not been first aroused, and then gradually developed and strengthened through the taking, handling and possession of the specimens, they would never have been ornithologists. An ornithologist is the result of a gradual development; he is not born ready-made. The interest first awakened by a specimen is rather vague. Then they learn to save what they are interested in; they handle specimens every day; and the beauty and the variety of characters presented attract attention more and more and lead to more detailed study. It is a gradual process of evolution and requires everyday contact. As an illustration, Mr. C. J. Maynard's interest dates back to the time when he was three years old. He remembers it distinctly, when his mother laid his first speci-

men before him, — a screech owl, and he has been working on birds ever since. When the State Ornithologist called for all those to rise to their feet, who began collecting when they were boys, every man stood up.

It seemed to be the general opinion that it would be better to err on the side of liberality in the granting of permits rather than to risk checking the development of the science, for it is growing increasingly difficult for the museums, for instance, to get young men for field work, since there are so few who are trained for it. It was pointed out that Massachusetts has always been a leader in conservation and in promulgating and enforcing good game laws, and whatever Massachusetts does will be followed by the western States. Rather than risk strangling ornithology over the whole country, it would be better to err on the side of liberality, for the belief was expressed that, after all, there are not enough birds killed by collectors to harm the stock. Undoubtedly far more are killed every year by sportsmen for food, which is perfectly legitimate. Dr. Nelson believes that at the outside not more than from 40,000 to 60,000 specimens are taken in this country by ornithologists in a whole year, so if, as estimated, there are 2,000,000,000 birds in the United States, that means but 1 in every 40,000 taken, which is a mere drop in the bucket. It is known that even where birds suffer tremendous losses, if they have a fair opportunity they will recover. For instance, a few years ago a spring storm killed off a large part of the bluebirds from Washington to Massachusetts, but they have since come back. One storm can kill off more birds than collectors would take in a century.

Mr. Winthrop Packard, Secretary of the Massachusetts Audubon Society, said that his feeling, on the whole, is, that while it would be a great pity to place hindrances in the way of a young man who is going to become a second Brewster or Forbush, he believes it to be wrong to provide opportunity to shoot birds throughout the State for collections, since there are many places where access may be had to collections. In his opinion it is not necessary for an earnest student to shoot birds for study. The amateur collector may do great harm, for instance, in this way. Some of the southern birds are reported

to be slowly moving north, like the mocking birds. There is always the impulse on the part of the young collector to rush out and get the bird for his collection, whereas if it had been left to breed, the range of the species would have been definitely extended. It was his feeling that the Commission would do well to use the utmost discretion in issuing permits. In the campaign of education that the Audubon Society is carrying on, they lay stress both on the economic standpoint and on the right of dumb animals to live. They believe that young people should be taught that the needless destruction of bird life is a very wrong thing.

Prof. Dallas Lore Sharp sums up his feeling thus: bird *protection* and not *collection* is now the concern of the State.

C. Emerson Brown, Esq., of the Zoölogical Society of Philadelphia (writing his views) was strongly on the side of those who would strictly limit the permits.

On the contention that studies can be made in the museums as well as in the field, Mr. A. C. Bent covered one angle of the question by saying: —

Here is a wholesome, outdoor recreation, which is absolutely harmless. There is no more harm in killing a robin or a bay-breasted warbler than there is in killing a duck. We should develop in the young man a good, health-giving, outdoor spirit, besides making an ornithologist, because we want all of the outdoor interest developed in the young men. Several times it has been said that there is no need of a young student making a collection of his own for study because there is sufficient material in museums. I grant that there is a vast amount of duplicate material in museums, but, since I have been preparing for the Smithsonian Institution my work on plumage changes, I have been astonished to find how much is really lacking, especially in young birds, and I have been through nearly all the large museums in California, Washington, New York, Boston and Philadelphia. I have also been through many big private collections, and I venture to say that there is not a single collection anywhere in this country that contains 50 per cent of the material that should be there to show what I want to know about birds. That is my experience. The material is not in the collections. But let us suppose the material were there. Going to a museum to study, the young man finds the room more or less dark, the birds are unattractive, and very soon he gets tired of it and gives it up; but let him go out into the fields and get his own material, and you build up the necessary enthusiasm to make him an ornithologist.

As to the problem of the taxidermist, he said: —

I was very glad to welcome what looked like a return of the privileges to the commercial collector. I looked at it from an ornithological standpoint. I have always thought that the commercial ornithologist is a necessary evil. A dealer is a natural clearing house. I do not see any reason why, just because a commercial dealer makes his living out of the buying and selling of specimens, he is any different from an ornithologist who accepts a salary from an institution, or in any way different from a man whom we send out to collect birds. This commercial element in ornithology is absolutely necessary if you are going to get the material you want, and I have been able to get specimens only by commercializing, by making it an object to the man I am sending after it. If ornithology is worth anything it is worth doing well. I think it would be safer to err too much on the side of overliberality than on the side of conservativeness. As to the question of permits to dealers, I think the abuse of privilege can be checked by requiring reports to be made of material bought and sold.

In the foregoing Mr. Bent expressed the sentiments that seemed to be commonly held by the ornithologists present.

Mr. F. Seymour Hersey of Taunton submitted his views by letter, saying: —

I think it is generally admitted that scientific collecting in this country has not usually shown any injurious effect on the bird life of the locality in which it has been carried on.

If permits were given to dealers (or taxidermists) *under proper restrictions* I believe it would cause no material decrease in bird life. I see very little difference between buying a bird skin from a dealer, and sending a collector into the field to obtain it; but museums and individuals regularly employ collectors, and most States will issue permits to such collectors. I think dealers should be required to submit sworn statements of the material handled and to whom sold. Dealers would not collect, or cause to be collected, more specimens than they could dispose of, and there is not a large destruction if his activities are limited to specimens for *scientific purposes.*

It is true, perhaps, that if dealers were allowed to regularly handle bird skins and eggs, it would stimulate interest in collecting to some extent, and there would be some increase in collectors, particularly among the younger men. However, most men engaged in advanced scientific work started as young collectors, and unless some encouragement is given to the younger generation it looks as if scientific ornithology would die out within a short time.

It is also true that some men who collect contribute nothing to science,

their collections being simply a source of recreation. Still, we admit that it is justifiable for men to hunt game as a means of promoting health or for recreation, and regulations are made so that all may enjoy this sport and that the game supply of the future may not be exhausted. Therefore I cannot see why the man who gets similar health and recreation from collecting should not, in all fairness, be allowed the same privilege, *under proper regulations, of course,* so that he will not exceed a reasonable quantity of birds. I am, therefore, forced to believe that permits should be issued to such people as have an interest in ornithology, even if they are not really advanced ornithologists, but they should first be vouched for by responsible and well-known scientists, and their activities should be regulated by restrictions based on the use they are likely to make of the specimens they collect.

Regarding your suggestion of a sort of clearing house for specimens, I might state that it is customary with owners of collections and museums to loan any desired material to those engaged in advanced research work along any line. It seems to me that the young beginner, who perhaps may be in some locality far from any museum, has a need as real as any for the privilege of collecting. He is usually without ornithological friends to whom he can turn for information, and his problems are therefore very real, although his work is only in the nature of self-education. In this connection I vividly recall my own early experiences.

William Brewster was absent on account of illness, and though unable to write at length, he said: —

My personal feeling always has been that if permits are granted to any one they should not be denied to either amateur collectors or professional taxidermists of good repute. Those men serve the museums usefully and accumulate much valuable information that is permanently recorded in ornithological journals and books.

The State Ornithologist expressed the belief that a man, to know birds, must collect them. He himself is handicapped in his work for lack of a collection.

For handling the very young boy the suggestion was made, that he should be taken under the wing of an older ornithologist, who would keep an eye on him and direct his efforts. This seems to be a very practical way to handle the situation, and met with approval.

Commissioner Pratt of New York stated that his state has been conservative in the past, but believes Dr. Nelson is right in saying that the only way to get a new crop of ornithologists

is by encouraging those young men who are taking it up seriously, but not the ordinary youngster who is taking it up for the sake of shooting; and the future policy in New York will be somewhat more liberal.

It was the feeling of those present, as expressed to the Board, that more frequent meetings of this sort for exchange of ideas would have a wholesome effect, bring the State officials and the public together, and serve to break down many barriers of misunderstanding.

The Commissioners were pleased to have heard the question discussed so thoroughly, pro and con, and feel disposed for the present to encourage the young men in the study of scientific ornithology and to help them in researches along biological lines. On the other hand, they will, as in the past, endeavor to make sure that this interest is of a genuine character, and that it is more than a passing fancy. In those instances where permits are given to young men, the Board will undoubtedly insist that they operate more or less under the oversight of well-known ornithologists, or under the direction of some one qualified to help them pursue their studies.

As to advanced ornithologists, the Commission will co-operate in all efforts to advance the scientific study of birds.

Commercial taxidermists of responsibility will on application be given permits to take such specimens as they may receive orders for from time to time, but under regulations which will inform the Board of specimens taken.

In 1919, 48 permits to take birds and eggs were issued; 46 reports received; 330 birds reported taken; 763 eggs taken; 7+ average number of birds taken per person, based on number of reports; 16+ average number of eggs taken per person, based on number of reports.

### *Migratory Game Birds.*

*Upland Plover.* — On Marthas Vineyard and Nantucket the spring flight of upland plover was very small, and a very few bred. This condition has prevailed for a number of years, and each year the numbers decrease. The largest breeding colony in that vicinity is to be found on No Mans Land, though there are fewer nests than two years ago. Throughout the entire

State they are scarce, and decreasing in the sections where years ago they were abundant. Here and there a few breed, but in no great numbers. The fall flight was very light. They are hunted very little.

*Black-breasted Plover.* — On the Cape the spring flight started May 22 and lasted until June 18. At Chatham and all along the marshes on the lower part of the Cape it was the heaviest in six years. There was also a very good flight in Bristol County, but none were seen in the inland districts of Plymouth County. On Nantucket there was a fairly good flight about the same time as last year, but they did not stop as long as usual. On Marthas Vineyard they are seen in smaller and smaller numbers as the years go on. In the northeastern section very few were noted. Some passed over Gloucester and vicinity, but did not stop. Very few were reported as traveling inland.

The fall flight on Nantucket was fair, and they were far more plentiful on Marthas Vineyard this fall than last. On the Cape the flight was normal. They were hunted on the Cape about as usual, but not to any extent in the rest of the southeastern section. Very few were seen in the district lying between Boston and Cape Cod, but in northeastern Essex County they were observed in good numbers, showing possibly an increase over previous years.

*Golden Plover.* — There was no fall flight of golden plover on Nantucket or on Cape Cod, but on the Vineyard they were present in greater numbers than last fall. A flock of 40 was reported from Edgartown Plains.

*Killdeer Plover.* — We are of the opinion that more killdeer plover were seen in the State this fall than for a number of years. In all probability this was due to the excessive rains and the resulting attractive area for the birds, which usually does not exist in the fall.

*Piping Plover.* — Piping plover nested along the coast of Cape Cod and on the islands, and are reported as having been unusually numerous at Dartmouth the end of June, at which time the young were as large as their parents and flying strongly. It seems certain that here this plover had a very successful season. On Marthas Vineyard more pairs bred along the south shore of the island than the previous year; on Nantucket,

about the same as last year. In other parts of the State a few nests were reported, and the numbers remained about the same. The smaller species of shore birds generally have shown somewhat of an increase over the preceding year.

*Woodcock.* — The spring flight of woodcock in the State appeared to be about normal. The reports indicate that the number of birds nesting in the State was slightly on the increase.

The breeding season was favorable. While there are occasional severe storms at some period or other during the breeding season, the woodcock seems remarkably well equipped to successfully weather these periods. It is interesting to state that a brood of young woodcock was reported on June 9 in Mashpee, and one in Harwich. No breeding birds have been reported on the Cape for many years.

The closing of the season on ruffed grouse had the effect of turning the attention of many of the gunners to woodcock, and in general they were more heavily hunted than usual.

Sportsmen commonly argue that the native birds generally have left the covers by the 10th to the 15th of October, depending a great deal on the weather conditions. It is also customary to speak of the weather as regulating, to a great extent, the migrations of these birds. It seems that, in so far as this State is concerned, at any rate, there is a wide field for further observation to determine the extent to which the movements of the birds are controlled by weather conditions. There is no doubt that most of our native birds had left by the time of the opening of the season this fall, but on the other hand, conditions could not have been more favorable for keeping them here. The general opinion of observers seems to be that at least the usual number of birds was found this fall during the usual flight time. The flight was somewhat "spotty," in some localities being heavier than usual, and in other localities lighter. Sportsmen are in the habit of hunting only those localities in which they have always found birds, and concluding that few have passed if the birds are not found in the old haunts. As a matter of fact, woodcock cover changes very greatly in a few years, and many sportsmen would be rewarded if, from time to time, they would seek new grounds.

*Wilson or Jacksnipe.* — There was nothing unusual about the spring flight, the birds appearing in about usual numbers.

The fall flight of snipe throughout the State was one of the most remarkable that has occurred in many years. It is impossible to say whether this was due to a favorable breeding season or to unusually favorable conditions. The large amount of rain rendered attractive to the birds parts of the State which are seldom frequented. Not only were the birds found in unusual numbers on some of their natural ranges, such as along the Concord, Charles, Sudbury and Neponset rivers, in the usual wet meadows in the middle and western part of the State, and in certain favorable areas along the Connecticut River, but they were found in such localities as damp places in cornfields where the corn was in the shock, and on extensive areas of the salt marshes which had been rendered more or less brackish by the heavy rainfalls.

*Dowitcher or Red-breasted Snipe.* — A gradual increase in this species is reported by Mr. Charles R. Lamb (who holds an ornithological permit from us) as having taken place during the past five years. Whereas five years ago he saw but an occasional bird, on Aug. 19, 1918, he saw a flock of 12 at East Orleans, which were seen again on the 20th; 6 others on the 19th; and at other times several more, single birds, and two's and three's. Though rather rare on Marthas Vineyard there were more this fall than last.

*Summer Yellow Legs.* — In the spring of 1919 there was quite a large flight on Cape Cod. More than usual were seen in southern Plymouth County, and greatly increased numbers in western Norfolk County, where there were large flights over Norton Reservoir. There was a good flight over the northeastern section. On Nantucket there were more summer than winter yellow legs, and quite a number — more than last year — stopped for a few days. On Marthas Vineyard this species has never made much of a showing in the past ten or more years, and usually but a few small flocks and single birds come. None at all were seen this year by the deputy.

On the return migration large numbers of yellow legs were shot on their natural range during the early part of the open season, which began on August 16. An unusually large number

of birds was taken on the marshes of Essex, Plymouth and Barnstable counties. The flight was not of long duration, but unusually heavy while it lasted.

*Winter Yellow Legs.* — In the spring the district deputy on Nantucket saw but few, though they were heard passing over in the night. Most of them passed outside of the island, and as the weather was excellent but few stopped. On Marthas Vineyard the flight grows smaller and smaller each year; but few birds were heard of this year. The last flight over this island which amounted to anything was in 1902. On Cape Cod a few were seen this spring, — far fewer than for a long time. The birds which passed over the southeastern section of the State seemed to have stopped on their spring migration, for reports from our deputies indicate that they were present in increased numbers. Large flights were seen over Norton Reservoir. On the west side of Buzzards Bay there was a large spring flight, which started exceptionally early and lasted unusually long. One flock of approximately 150 birds was reported. There were good flights, and the birds were seen in increasing numbers around Kingston and Duxbury. They passed over the northeastern part of the State in large numbers, but did not stop. There was a large flight in northeastern Essex County between May 25 and June 10, and in southeastern Essex County the flight was heavier than for many years. A large flight was noted at Hingham and Weymouth.

On the return migration the birds came along at the usual periods, but the flight seemed to last a little longer into the fall than usual. Good flights were reported on most of the marsh areas along the shore. Fewer birds than usual stopped inland. It is interesting to note that on some of the areas around a few of our inland ponds it is usual to note a substantial flight of both summer and winter yellow legs.

*Sandpipers.* — On Cape Cod a good many were seen, but they are not increasing as fast as they should under the protection afforded by the Federal law. In the southeastern section there are larger and larger flocks every spring, and the birds are undoubtedly on the increase. On Nantucket the flight was small. On Marthas Vineyard, as time goes on, sandpipers show a very marked loss in numbers. Only a very few have been

seen in the past three years in comparison with a few years ago, when one could see them by the hundreds along the shore beaches. This spring only spotted sandpipers were seen on the island. Over the State as a whole there is a pretty general increase in the abundance of the solitary and the spotted sandpipers. More were seen in Berkshire County this spring than at any time in the past ten years.

*Willet.* — According to the observations of Mr. Charles R. Lamb the willet, like the dowitcher, has gradually increased during the five years past.

*Curlew.* — There were few seen this spring, — four or five at Nantucket; two sicklebill curlew at Kingston; and a few were seen in flight in May around Gloucester.

An unusually large sicklebill was seen on Chappaquiddick on September 18. The bird skulked through the grass, rail-fashion, and was not found, after having been observed lighting on the thatch at the edge of the grass. Later it was observed for some time on the edge of a small slough hole, at a distance of 20 yards. On being flushed it flew out over the water in the direction of Nantucket and disappeared from view.

On the return flight more Jack curlew were seen this year than in the season of 1918 on Marthas Vineyard and on Nantucket. Though not appearing in sufficient numbers to be called a "flight," more were seen than for a number of years. A few were reported from the Slocum River in South Dartmouth, and a small number along the Duxbury shores. More than usual were noted in northeastern Essex County.

*Godwits.* — In the vicinity of Annisquam, about August 25, a few Hudsonian godwits were seen, the first noticed or reported there for some years.

*Rail.* — Though a few years ago the Virginia rail was quite common and bred around Pocha and Squibnocket ponds on Marthas Vineyard, at present they are less common, and none have been heard of this year. Elsewhere in the State there were none, or but very few, seen in the spring. Some of the rare black rail are reported to be in the Whitman marshes.

During the fall practically no rails were seen on Marthas Vineyard, and very few on Nantucket. In fact, "very few" or "fewer than usual" was the general report for the entire

coastal district. Inland, too, there were few, though there was fair shooting of sora and a few Virginia rails at Longmeadow, and a few sora were taken in the vicinity of Easthampton.

*Wood Duck.* — Wood ducks are seen very little along the shores, being a bird of the inland water courses and small ponds. During 1919 they are reported in the northern and northeastern parts of the State as increasing in fairly good numbers, quite a number nesting in these localities. In the southern and southeastern part very few are reported as having been seen, either nesting or in flight.

*Mallard Duck.* — There were few reports of mallards seen in the spring, and practically all those were birds liberated by the Commission. All birds liberated from the duck farm at Marshfield are marked with an identifying band. Most of the bands returned to us are found on birds shot in Massachusetts. But that these propagated birds do migrate, and travel long distances, is proved by the return of band No. 275 from Lake Manitoba, 59 miles from Winnipeg, Manitoba, on October 11; No. 350, found on a mallard duck killed at Norfolk, Neb.; and No. 904, on a drake killed at McFerren, Ark., November 8. Only a small proportion of the bands are returned to us.

*Red Heads.* — Red heads were very scarce in the spring of 1919, and very few were seen in flight. On Marthas Vineyard but few were present during the winter and spring of 1918–19, far less than other years, but in the fall they put in their appearance again and were quite numerous. They were also unusually abundant in Barnstable County, but scarce on Nantucket. In the latter place they have been scarce for years.

*Canvas-back Duck.* — Canvas-back ducks are still very scarce, and not many were seen in the spring flight of 1919. A flock of about 25 was observed by the superintendent of the Marthas Vineyard Reservation in Job's Neck Cove of Edgartown Great Pond, the only ones seen by him this spring. They are not increasing there, but, on the contrary, smaller numbers are coming each winter and fall.

Very few were reported in the State this fall. A flock of 8 was seen in Edgartown Great Pond November 17, and the district deputy reports that one pair — the only pair he ever knew of in his district — was shot in Windsor Pond, Plainfield.

*Black Duck.* — Ever since the passage of the spring shooting bill these ducks show up year after year in increasing numbers. This continued increase prevailed in the year 1919, and was true for the entire State, with the exception of Berkshire County. Whereas for a number of years past the ponds and streams have been closed by ice, during the past mild winter fresh water was easily available, which held the birds here and made it unnecessary for them to continue farther south. Large numbers wintered all through eastern Massachusetts. Practically the only place where scarcity was noted was along the Ware River marshes.

*Scaup or Blue Bills.* — The spring flight was reported as normal, having in mind a comparison with the past five years. The fall flight was heavier than usual, with indications that this duck is on the increase.

*Sheldrake.* — The spring flight was smaller than usual, but sheldrake are reported as having been seen during the previous winter (1918–19) in much greater numbers along the coast from Plymouth to Newburyport than ever before. The same abundance prevailed in Boston Harbor and along the Merrimack River. This was due to the mild winter, which allowed them to secure feed without difficulty. In the southeastern section the fall flight was unusually large, especially in November. On Nantucket it was fair, but late. They were present in good numbers in the northeastern section.

*Scoters.* — Along practically the whole coastline scoters were reported as being very plentiful, — fully as numerous as ever before. Undoubtedly many of them wintered north of Cape Cod, along with the sheldrakes. The fall flight in Essex County started early in September, and is reported as being the largest for twenty years. The flight was also large through the southeastern section.

*Geese and Brant.* — As stated in last year's report, the flight of geese and brant in the fall of 1918 was late in coming along, and up to Nov. 30, 1918, comparatively few had been seen. The bulk of the birds came after Dec. 1, 1918, in greater numbers and much later than usual. They appeared to have been held back by the mild winter, which allowed them to remain longer than usual on their feeding grounds in the north. They were flying as late as Dec. 20, 1918, at Nantucket. The fore-

going applies particularly to the southeastern section of Massachusetts. Only occasional flocks were seen in the northeastern part of the State or inland. None wintered north of Boston, but quite a number did so along the southeastern coast in various localities, *i.e.*, a large flock of geese in Nantucket Sound between Monomoy (Chatham) and Great Island (Hyannis); about 40 in Long and Hummock ponds, Nantucket; several hundred brant on Muskeget. About 400 geese wintered in Westport River and Slocum River; and there were a very few brant (which are rare in this locality) with them. More than the usual number remained in the waters adjacent to Marthas Vineyard.

The spring flight was earlier than for the past few winters, for the mild weather carried away the ice and snow early and uncovered their food supply and breeding grounds. There were good flocks of both brant and geese on the northern migration, comparing favorably with preceding years. Indeed, reports indicate increasing numbers. It was heaviest in April. In the Buzzards Bay district the flight, in greater numbers than usual, began the latter part of February and lasted until about the 11th of April. On Nantucket they came about March 20, and the flight lasted approximately six weeks; geese in about the same numbers as in previous years, and brant more numerous. In southern Plymouth County they appeared the last of March and flew for four weeks about as usual. They were first seen in Kingston and Duxbury March 8 to 14, one observer noting 500 to 1,000 at Duxbury Beach. They were seen in western Norfolk County as early as March 7, and the last were observed April 8. On Cape Cod large numbers of geese were flying April 18, 22 and 25, and large flocks of brant were reported April 13 by William Gould of Chatham. On the north shore the birds came along a little later than reported in southern localities — from April 20 to May 10 — in unusually large numbers. In northwestern Essex County and extreme northeastern Middlesex County the first flock came March 8.

The fall flight of 1919 up to November 30 was heavier, broadly speaking, than has been noticed in this State for a number of years. The birds came earlier than usual. The first ones appeared on Marthas Vineyard on October 4. In the

region about Marthas Vineyard, on or about November 10, when the second flight is usually looked for, there was a period of ten days of extreme high north and east winds, and no birds appeared.

It was reported to us by an old gunner of many years' experience that on October 8 he saw a flock of 4 white or snow geese on Essex Bar in Ipswich. On the 18th of that month a young snow goose was shot on the Newbury marshes.

Following are the statistics of the gunning stands operated during the open season of 1918 (September 16 to December 31) as compared with similar figures for 1917: —

| Year. | Number of Stands operated. | Number of Decoy Ducks used. | Number of Decoy Geese used. | Number of Ducks shot. | Number of Geese shot. |
|---|---|---|---|---|---|
| 1917, | 67 | 2,093 | 1,793 | 3,495[1] | 726[1] |
| 1918, | 53 | 2,112[2] | 2,452[2] | 5,349[2] | 2,065[2] |

[1] Data for 51 of the 67 stands operated. No figures available for the other 16.
[2] Data for 52 of the 53 stands operated. No figures available for the other 1.

*Swans.* — A pair of swans were seen in the Slocum River, Dartmouth, June 22. There were reports of a pair in Quicksand Pond, Rhode Island, and Allen's Pond, Dartmouth — doubtless the same pair. Seven were in Squibnocket Pond about November 5, and remained about a week. One solitary swan was seen at Oldham's Pond, Halifax. It remained around three or four days.

*Lighthouses* v. *Migratory Birds.* — To verify the results of last year's investigation as to the extent to which lighthouses in Massachusetts are responsible for death of birds on migration, the same inquiry was made covering 1918. Comparison with the previous year's returns shows: —

| | 1917. | 1918. |
|---|---|---|
| Number of reports received, | 51 | 52 |
| Number of keepers who reported none killed, | 35 | 35 |
| Number of keepers unable to furnish data, | 3 | 8 |
| Aggregate number of birds killed, | 383 | 130+[1] |

[1] Cape Cod Light reports that "many small birds" were killed at that light. Nantucket Light, that "a great many snow birds" were killed.

*Migratory Bird Situation.* — Without attempting to particularize in respect to any one species, the general impression is that the song and insectivorous birds and wild fowl are on the gradual increase. It is impossible to make more than this general statement at the present time. A period of years will have to elapse before a general feeling of security for the future of the birds will be felt. In relation to wild fowl there are several considerations; history shows that there may be a good flight on the return migration in one year, to be followed by two or three or more lean years. If it turns out that the flights for the next few years show a gradual increase, we will be justified in assuming that the improvement will be permanent. In our State the elimination of spring shooting, in the opinion of many observers among the sportsmen, has had a great deal to do with the gradual increase of wild fowl.

### *Migratory Non-Game Birds — Gulls and Terns.*

The policy inaugurated last year of appointing special deputies to guard the more important seabird colonies during breeding season (May, June and July) was continued, and extended to three additional locations, — Monomoy, Gull Island and Nauset Harbor.

*Chatham Colony.* — This colony of common or Wilson terns was again under the care of Bartlett E. Bassett. The birds nest in four localities, — on the north beach, on the south beach and on two small islands. Changes have taken place at the north beach, so that there is now a safe breeding place in the location where last year the eggs were washed out by the tide. The first terns, 14 in number, were seen May 9, one week earlier than last year, but showed no signs of nesting until May 16.

On the south beach the birds bred earliest, and in far greater numbers, than on the rest of the breeding area. By May 22 there were many nests, but no eggs; May 24, 10 nests of 1 egg each, and 2,000 to 3,000 adults; May 30, 3,000 to 4,000 adults and quantities of eggs. By June 18 there were a few young, and more terns laying. Eggs low down on the beach were washed away by the tide early in the season, but the birds hatched on the higher part, and by June 21 the grass was full of young birds, and they were growing well. On July 2, as a

result of heavy rains the week before, a number of young were found dead, but the greater part were doing well and many were over half grown. Laying was continuing to some extent, and there were 6,000 adults in the colony. By July 18 many of the young were flying and trying to fish.

On the north beach nesting was later. The first egg was found May 24, and only a few terns were scattered over the beach, but by May 31 they were there in good numbers, some 3,000 or 4,000, and though there were many nests, not many birds were laying. By June 3 laying was coming along faster. On June 12 the beach was well covered with eggs, and laying continued. Hatching began June 21 and proceeded with no particular setbacks.

The birds nested again on the small islands, nest building commencing the 20th of May, and laying on the 26th. On May 28 there were 500 terns, 74 eggs and quantities of nests. On June 7, 240 eggs were counted on one of the islands, and prospects were promising for a good hatch. Hatching began July 24 and a few young were seen on the 30th, but a great many eggs had disappeared, and some appeared to have been eaten by birds, possibly crows. Only a few adults were about, and only about a dozen nests with eggs. Cattle put to pasture on the island drove off the remaining terns, and the breeding on the islands was a failure.

About the middle of June some 300 or 400 terns came into the Chatham Colony from somewhere outside and began to lay (perhaps disturbed in nesting elsewhere, or they may have been young birds of last year's hatch, which would breed later) on the low part of the north beach. As the resulting young could not be on the wing and able to care for themselves for three weeks at least, warden service was extended one month. By August 26 practically all the young of the second laying were able to fly. It was a very good year for the terns at this location, despite some losses of young from chilling in the rains at hatching time. The losses, however, were comparatively small, and the end of the season saw a fine lot of young birds.

About 20 pairs of least terns nested on the north beach and hatched a few young. Six nests with eggs and five with young were noted June 27. This is the first instance, in the

caretaker's forty years' experience, where least terns have bred here.

There was but one breach of the laws during the year. On July 23, in the absence of the district deputy on other work, four Italian fishermen went ashore on the south beach and gathered up 27 young terns, with the intention of carrying them away to eat. The sheriff was notified, and the four men brought into court, where they paid fines of $10 each. The captured terns were released.

*Katama Beach Colony.* — Sylvanus E. Norton was placed again in charge of this colony, where some 200 least terns and the same number of common or Wilson terns bred. Nests of the least tern were found as follows: May 31, 35 nests; by June 7 they had increased to 78; by June 14, to 93; by June 21, to 102; by July 12, to 104. The common tern nests numbered 25 on May 31; 74 on June 7; 104 on June 14; 115 on June 21; 120 on June 28; and 126 on July 12. Hatching was practically over on July 5. During nesting time in May the weather was cold, windy and rainy, but the end of the month it turned clear and hot, and remained so through the entire hatching and growing period. During the season 1 cat was killed and 2 crows which had destroyed half a dozen nests. No other vermin was seen, and probably all was killed off last year. Aside from this there was nothing to disturb the birds.

*Monomoy Colony.* — This colony consists of common or Wilson terns, with smaller numbers of least terns, laughing gulls, herring gulls, roseate and Arctic terns. It was in charge of George W. Bloomer. The site is a strip of beach half a mile long and 200 yards wide; sandy, with small grass knolls, the highest not more than 6 feet above sea level. The contour of the shores is constantly changing, and the nesting site has formed within the last four years. The colony started three years ago. There were then no knolls or grass, and consequently the breeding was not extensive, perhaps 200 nests and 600 eggs, many of which on very high tides were washed away. A very suitable breeding ground has gradually developed, and is occupied by a colony having some 15,000 eggs.

The birds used a new breeding ground this year in addition to the old. It is newly made land formed during the last two

years, making off from the main beach at Monomoy Point lighthouse in a south-southwest direction (the main beach extending in a southwest direction), thereby leaving a good harbor between, with 13 feet of water at low tide, and filled with fine bait, furnishing excellent food for the terns. The birds bred on the outer beach or new land, where seaweed and beach grass made excellent nesting places.

The common terns nested on the northern and central part of the colony. On May 25 there were 10,000 common terns, with 144 nests containing 206 eggs, though none as yet with 3 eggs. Almost daily inspections were made. The first nest with full quota of 3 eggs was found May 28, and by the 30th egg-laying was increasing rapidly. On June 13 a count showed, on 400 square feet of land, 32 nests and 88 eggs, as follows: 1 nest of 4 eggs; 24 nests of 3 eggs each; 5 nests of 2 eggs each; and 2 nests of 1 egg each.

The first young birds were seen June 18. On June 20 two adults were found dead on their nests, each with 3 eggs under them. One bird, yet warm, had been shot in the left side of the breast. It was not shot on the colony. At this time the young were hatching in large numbers, and the heavy rain and fresh winds of June 27 and 28 caused the loss of about 7 per cent of the young. The 1st of July brought very warm weather and perfect growing conditions, and by the 7th some of the young were starting to fly and the parents busy feeding them. Egg-laying was practically over. By the 12th the young were rapidly taking wing. The heavy rain of July 16 had no ill effect on the young, now on the wing by the hundreds. By August 10 they were all able to take care of themselves.

Herring gulls are believed by the caretaker to have bred on this location last year. Therefore on June 24 he made a special search to ascertain whether they were doing so this year, but failed to find any evidence. He reported that on August 15 many young herring gulls, able to fly, were roosting on the south end of the colony. These may either have been hatched here or may have come in from other breeding grounds.

Laughing gulls bred in the colony last year, and this year about 40 adults were breeding on May 30 on the south end. At least 60 young were hatched.

A few least terns bred on the northern end of the colony. About 150 young were reared, — 110 on the colony and 40 on the inner beach.

Arctic terns to the number of about 200 bred on the southern end of the colony. In this instance the Arctic as well as the roseate terns were later than the common terns in egg-laying, and therefore also in hatching. Many eggs had not yet hatched on July 17. The young appear to be hardy and are less susceptible to unfavorable weather than the common terns. By August 6 good numbers were hatching. The adults fed the smaller fledglings with minnows, but the larger ones, nearly ready to fly, were given the young mackerel 3 to 5 inches long with which Chatham Bay was swarming. On August 14 there was a heavy gale of wind with rain, but the young birds, though shivering, were hardy enough to stand the storm. About 575 of this species were reared to maturity.

Roseate terns bred on the southern end of the colony, to the number of about 325. A count July 18 showed —

| | Per Cent. |
|---|---|
| Young able to fly, | 60 |
| Running about, | 15 |
| Unhatched, | 18 |
| Perished in rain, | 7 |

Like the Arctic tern, these bred this year later than the common tern. The young were fed by the parents after the manner of the Arctic terns. Both Arctic and roseate terns joined the Monomoy Colony from outside, and began to lay about the end of July, when the breeding season would usually be over. Therefore, to give this second hatch every protection, warden service was extended to the end of August. It is estimated that at least 625 young were hatched.

No great amount of vermin was about the colony. Only a few cat tracks were found. Two cats were killed and another crippled, and none were seen thereafter.

*Gull Island Colony.* — This small uninhabited island, about 300 yards long and 30 yards wide, is located in Buzzards Bay about 2 miles northeast of Cuttyhunk. It is very rocky, having but a very little grass along the crest of the beach; comparatively level, standing about 10 feet above sea level. Only

one species breeds there, the common or Wilson tern. This colony was placed in charge of Mr. Seva Howes of Cuttyhunk. By covering the stones above high-water mark with seaweed he arranged more attractive nesting places for the birds than the place naturally afforded. By May 27 there were about 100 terns and a dozen nests with 15 eggs. The number of birds increased by June 3 to 200, and varied from 100 to 200 throughout the season. Laying proceeded, eggs numbering 54 on June 3 and about 200 on June 10, when the first set was completed. By June 24 about 100 young had hatched, and by the 26th all but 6 of the first nests had hatched. On that date 5 new nests (1 and 2 eggs each) were found, the beginning of a second set. On June 30 there were 30 new nests, the remainder having hatched. By July 5 there were 41 eggs; July 6, 73 eggs; and July 14, 50 eggs and 30 young.

The caretaker visited the colony every three or four days, but found very little throughout the season to disturb the birds. Though hawks and crows were seen, there was no direct evidence that they destroyed eggs or young. There was a good deal of rain, but only a few bad storms during the hatching and growing period, and as a whole, the general result of the season was satisfactory.

*Nauset Harbor Colony.* — This locality has been a breeding ground for the common terns for some thirty-five or forty years. They breed in three localities, — North Beach, Stony Island and Sandy Flat. North Beach is 3½ miles long, covered with beach sand, and the birds nest in the débris that washes in. Sandy Flat is about 40 acres of sand dunes and salt meadow. Stony Island is small in area, and its name describes its character.

Mr. Daniel B. Gould of Orleans was appointed caretaker, and visited the colony practically every day. His first inspection on June 1 showed about 3,000 birds, and egg-laying was well under way. There were then about 1,000 eggs, and laying continued for a considerable time. Hatching began around June 20; by the 26th young were seen in good numbers; and by July 19 the birds of the first hatch were flying. Normally the breeding season would be over by the end of July, but about the middle of the month other terns joined

the colony and began to lay. In order to give this new set every chance to mature, warden service was continued to August 31. The second set began hatching August 6, and young were seen in good numbers. They grew rapidly, and by the 31st eggs were all hatched and the young flying.

Mr. Seymour Hersey reported to us that the roseate terns which formerly nested here have left the colony at Nauset Beach, and it is probable that the bulk of them went to Monomoy. The few that remained at Nauset began laying May 31, when 8 or 10 nests with single eggs were found.

No vermin was seen through the entire season. Weather during the hatching and growing period was reasonably favorable, but high tides and storms broke and washed away quantities of eggs. Possibly one-quarter of the set was thus destroyed. A considerable number of young were killed by high tides and sandstorms, but on the whole it was an average good season, and at the close the colony was estimated at 5,000.

The State Ornithologist, as a part of his general inspection of sea-bird colonies, visited the five breeding grounds just described. He found in general that in all the colonies to the south and west of Cape Cod there had been a great mortality of young birds. Practically all of the colonies, except those in ponds, had been washed more or less by the sea, but this is generally due to the habit of some of the birds of building their nests on too low ground. The chief cause of the destruction of the young is not known, but evidently many were killed by severe rainstorms and others by cats; still others, as well as some of the eggs, were destroyed by birds. The crow is the only one which can be positively convicted, though some suspicion attaches to the gull, and in one case to night herons.

It would be a satisfaction to be able to place wardens on all the sea-bird breeding grounds in the State, but thus far appropriations have not permitted. The more inaccessible ones, however, stand less in need of care. A general survey of the principal colonies, made through the district deputies, showed that the gulls and terns are increasing in numbers along our shores, though in some localities the growing summer population is driving the birds to more remote spots.

*Nantucket Colonies.* — The colony of laughing gulls at Muskeget Island (the only place on the Massachusetts coast where they breed in large numbers) is increasing rapidly in size. This species was once near extermination in this State. A small breeding colony of laughing gulls started last year at Monomoy. The breeding season on Muskeget was good, and least and Wilson terns, in addition to the laughing gulls, bred in thousands. Here, as was also the case on Marthas Vineyard, many of the young were destroyed, possibly by cats.

There was formerly a large colony of terns at Siasconset Beach, but the number of visitors in recent years has broken it up, and now only about 500 birds breed. There is no increase.

At Wauwinet Beach a small number of least terns, from 300 to 400, breed, but the presence of people prevents increase.

At Surfside Beach about 2,000 common and least terns breed. They had a good season, and are on the increase.

*Marthas Vineyard Colonies.* — The shores of Marthas Vineyard and many of the ponds support numerous small colonies of terns, in addition to the large one at Katama Beach, already reported on.

Job's Neck Pond colony consists of Wilson and least terns. A count by the deputy on June 8 showed 64 least and 52 Wilson tern nests, with eggs. On the 17th there were 15 Wilson tern nests, 55 least tern nests, and several young of the latter. Last year the eggs were destroyed by a heavy storm at sea which caused the breakers to wash over the beach where the eggs were, but this season the eggs were hatched with no such mishaps. The State Ornithologist informs us that most of the young on Marthas Vineyard have been destroyed by some agency. Very few young were found by him on the shore, and almost none on the wing.

The Cape Pogue colony of Wilson terns, located on Little Neck, had about 40 nests this season.

Edgartown Great Pond colony, on Swan Neck Island, at the extreme east end, consists of Wilson terns. There were 27 nests.

Eel Pond colony — a new one — consists of about 30 nests of Wilson terns.

The Chilmark Pond colony of Wilson terns is extinct on the island on which they bred, but a new colony has started on the outside beach. This includes some least terns.

Other colonies which, owing to lack of funds for close inspection, we are unable to report on, are Cirson's Island colony of Wilson terns and Oyster Pond colony of least terns.

*Ram Island Colony.* — This island, a quarter of a mile south of Mattapoisett Neck, is the resort of about 2,000 common or Wilson terns. Hatching was proceeding under ideal weather conditions when our deputy inspected it on June 22. He counted about 400 eggs, 15 young and 4,000 adult birds. Two snowy owls were on the island last winter, which no doubt reduced the number of mice. There is nothing to disturb the birds in this place, and they are increasing.

*Truro Colony.* — This colony, which is located on a long, narrow, grass-covered sand bar off the Truro shore, has been growing up during the past few years, the numbers steadily increasing. At the beginning of the season it consisted of over 1,000 Wilson terns.

## Upland Game Birds.

### *Pheasants.*

In those portions of the State where pheasants have established themselves they came through the winter in excellent shape. It was an ideal winter for all birds, — mild and open, with little snow, no sleet and no continuous cold. There was practically no time when grass and weed seeds could not be obtained above the snow, and gravel was accessible throughout most of the winter.

It is reasonable to state that throughout the winter range there were probably fewer birds for brood stock than during the preceding year. This condition, however, was offset by the unusually favorable breeding season. The numbers of young birds were reported as larger than usual. The only exception to the foregoing is the condition in Berkshire County.

There the pheasants are reported few in number, and they appear to have made little headway in establishing themselves, though this county receives its share of birds for stocking purposes each year. While it is true that in this area the birds must face the most rigorous winter conditions of any part of the State, nevertheless a good food supply exists and they will get by. Pheasants will "bud" apple trees, and they have been reported budding birch trees. We will continue our investigations as to the causes which seem to work against the bird in this region.

At the present rate of stocking the pheasant is about holding its own. As a result of the scarcity of the grouse in the season of 1918, many conservative sportsmen hunted the pheasant almost exclusively. The closed season on grouse this year compelled many sportsmen to hunt pheasants where heretofore they had given them very little attention. The result has been heavier shooting, and this means that increased efforts to distribute larger numbers of the birds should be made. Oftentimes the advisability of introducing a new species is debatable, but this is one case where it is a great satisfaction to report that a bird artificially propagated in the first instance has provided good sport, and has been the bulwark in protecting a native species during a critical period of its existence.

*Open Season.* — An open season on pheasants was declared by the Board in accordance with chapter 401, Acts of 1914, from Oct. 20 to Nov. 20, 1919, in all counties except Dukes, with the usual regulations of two in one day or six in the season to each hunter, and all birds killed to be reported to the Commission within twenty-four hours.

This year, for the first time, the season was opened on pheasants on Nantucket. The sentiment on the island favored this action, and the number of birds warranted it.

The total number of pheasants reported as having been taken this season exceeded the total of the previous year by 583, and each year's open season proves that the annual increase of these birds is just about sufficient to provide a month's shooting and keep the birds at average numbers. Following are the statistics of the open season of 1919: —

*Pheasants shot in Open Season of 1919.*

| County. | Cocks. | Hens. | Total. |
|---|---|---|---|
| Barnstable, | 4 | 3 | 7 |
| Berkshire, | 9 | 8 | 17 |
| Bristol, | 104 | 80 | 184 |
| Essex, | 166 | 105 | 271 |
| Franklin, | 38 | 16 | 54 |
| Hampden, | 101 | 73 | 174 |
| Hampshire, | 116 | 72 | 188 |
| Middlesex, | 524 | 331 | 855 |
| Nantucket, | 97 | 47 | 144 |
| Norfolk, | 205 | 124 | 329 |
| Plymouth, | 83 | 41 | 124 |
| Suffolk, | 5 | - | 5 |
| Worcester, | 94 | 57 | 151 |
| Locality not reported, | 2 | 1 | 3 |
| Totals, | 1,548 | 958 | 2,506 |

Very few cases of damage by pheasants have been reported to us in the past year, and the insect-destroying habits of the young bird are beginning to be better understood. Likewise the value of the bird as a food supply is being recognized, and its qualities as a sporting bird are improving.

## *Ruffed Grouse.*

The reports of our deputies and all other observers at the end of the open season in 1918 showed the advisability of suspending shooting of ruffed grouse during the season of 1919. Our Board recommended this to the Legislature, and such action was taken (chapter 153, General Acts of 1919). In the other New England States legislative measures of one kind or another for the protection of the ruffed grouse were enacted in Maine, New Hampshire, Vermont and Connecticut.

The number of birds which appeared during the winter of 1918–19 showed a further decrease. It is a common remark among sportsmen, when the grouse do not appear during the open season, that when the cold weather comes and the birds

are driven out on to the edges and into the runs, plenty of birds will be found. Our observation is that if the birds do not show up in good numbers during the open season, assuming usual conditions, they are not likely to appear later on in any relatively increased numbers. This was true during the winter of 1918–19.

The favorable breeding season of 1919 was looked upon as a good omen for the grouse. The general opinion is that such birds as were left bred exceptionally well.

Speaking of the State as a whole, our survey indicates that there were more birds this fall than during the preceding year. It is too early to state definitely what the survey will show during the coming winter, when there will be the opportunity to make a most careful study (this report ending November 30). In a few localities the birds have been reported in greatly increased numbers. Some areas seem to have been little affected by the causes which brought about the general decrease. If it were not for the fact that in a few areas good numbers of birds are to be found, the outlook for the grouse would be very discouraging indeed.

### *Quail.*

As was the case with wild life in general this year, the quail came through the winter well and there was no great degree of mortality. We are coming to appreciate more and more the many benefits to be derived from bringing the brood stock through the rigors of winter in good physical condition. It is a common statement that many of the birds can take care of themselves in the most rugged weather. While this is true in many cases, nevertheless the struggle necessary for survival in many localities impairs the vitality of the birds, and this is reflected in the quality of the following year's hatch.

The amount of brood stock at the opening of the mating season was normal, or even a little above the average of abundance in the natural quail section. It is interesting to note that in certain sections of the middle western part of the State the quail seem to be gradually on the increase. We

refer particularly to the region of southwestern Worcester County and eastern Hampden and Hampshire counties.

The results of the breeding season were very satisfactory, the broods being many and large; and the year's increase was proportionately large in those parts of the State less abundantly stocked with quail.

Close seasons the year round prevail in certain counties which had become almost entirely destitute of quail, namely, Essex County (since 1914); Middlesex County (since 1917); Hampden County (since 1917); Nantucket and Dukes counties (beginning with 1918). Present conditions in these counties are, briefly: —

On Nantucket there have been very few quail for the last ten years, and the hard winter of 1918 killed off what few remained. Only one was heard of by the district deputy during 1919.

On Marthas Vineyard (Dukes County), in the fall of 1918, the coveys were quite large for that locality, flocks of 25 being common, and they came through the winter very well. In the early spring of 1919 several flocks were noted by the superintendent of the heath hen reservation, though none as large as during the early part of the previous winter. Wood cats, which abound on the island, and some illegal shooting are doubtless responsible for the reduction in the size of the flocks. The breeding season was good, and residents of Menemsha claim that there have been more quail in the western half of the island than for the past ten years. Favorable reports came also from Edgartown.

In Middlesex County there are very few quail; and, owing to the great scarcity at the time protection was extended to them, there has thus far been little increase.

In Hampden County our deputies' reports indicate that in some portions of the county there was an increase in the number of breeding birds, though in other portions the numbers were smaller. Several broods of young were reported, and from the eastern part of the county farmers report that quail are showing up in places where they were formerly extinct.

In Essex County a few single quail were heard in a number of localities at the opening of the breeding season. A few

small broods were reported, and at least one brood is known to have resulted from the liberation of six adult birds in the spring. The fact that at least 25 persons have reported hearing quail during the summer of 1919 goes to prove that they are slowly re-establishing themselves where for twenty years they were practically extinct.

### *New Species.*

The attention of the Board was called by Mr. James W. Meloon to the tinamou, a bird native to South America. It was his opinion that it might be successfully reared in captivity for propagation purposes. Correspondence was opened with officials of Chile and Argentina as to the possibility of importing some for experiments in breeding, and for observation, to judge whether they would be a valuable addition to the game birds of this Commonwealth. Through the American Consular Service at Buenos Aires, Argentina, it was learned that unsuccessful efforts along this line had been made in France, in view of which it seemed inadvisable to repeat the experiment in this country.

## Game Animals.

### *Deer.*

A comparison of the number of deer at the beginning of this year with the last few years shows that in the southeastern section there was no very marked change over their range, the numbers remaining about normal. Variations in certain localities may be attributed to the disposition of the deer to roam. Northeastern Massachusetts is not a deer section, and there a gradual falling off in numbers takes place from year to year. In the west central part, too, there are fewer. In the region still further west they are holding their own.

Winter conditions were favorable, food abundant and easy of access, with no deep snows or severe cold. Owing to this the deer did not yard to the usual extent. The physical condition of the deer was good, and such as could be examined were smooth-coated and fat. There was little chasing of deer

by dogs, owing to the small amount of snow and lack of crust.

We have almost uniform reports from all districts that very few complaints have been made of damage by deer. Farmers have availed themselves of the law permitting deer to be shot while damaging crops to the extent of 141 deer in 1919; 64 of this number were shot in Franklin County. The amount paid on account of damages by wild deer was $4,891.90.

Since this report covers the period of the fiscal year (Dec. 1, 1918, to Nov. 30, 1919) statistics of the open season of December, 1918, coming within this period, are given here. The season was open in all counties except Suffolk.

*Record of Deer shot in Open Season of 1918, December 2 to December 7, inclusive (within the Fiscal Year 1919).*

| | Barnstable. | | Berkshire. | | Bristol. | | Dukes. | | Essex. | | Franklin. | | Hampden. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Bucks. | Does. | Bucks. | Does. | Bucks. | Does. | Bucks. | Does. | Bucks. | Does. | Bucks. | Does. | Bucks. | Does. |
| December 2, . . . . . . | 4 | 2 | 19 | 13 | 1 | 3 | - | - | - | - | 17 | 14 | 9 | 6 |
| December 3, . . . . . . | 5 | 3 | 19 | 6 | 4 | - | - | - | 2 | 1 | 32 | 22 | 12 | 12 |
| December 4, . . . . . . | 1 | - | 15 | 6 | 1 | - | - | 1 | - | 1 | 14 | 13 | 8 | 9 |
| December 5, . . . . . . | 5 | 3 | 15 | 11 | 1 | - | - | - | 1 | - | 9 | 12 | 1 | 7 |
| December 6, . . . . . . | 3 | 2 | 17 | 12 | 2 | 2 | - | - | - | - | 13 | 12 | 17 | 12 |
| December 7, . . . . . . | 3 | 3 | 17 | 13 | 6 | 6 | - | - | 2 | - | 18 | 19 | 11 | 7 |
| | 21 | 13 | 102 | 61 | 15 | 11 | - | 1 | 5 | 2 | 103 | 92 | 58 | 53 |

*Record of Deer shot in Open Season of 1918, December 2 to December 7, etc.* — Concluded.

| | Hampshire. | | Middlesex. | | Norfolk. | | Plymouth. | | Worcester. | | Total for State. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Bucks. | Does. | Bucks. | Does. | Bucks. | Does. | Bucks. | Does. | Bucks. | Does. | Bucks. | Does. | Total. |
| December 2, | 9 | 4 | 1 | 1 | - | - | 9 | 3 | 11 | 8 | 80 | 54 | 134 |
| December 3, | 16 | 15 | 3 | - | 1 | - | 8 | 3 | 13 | 6 | 115 | 68 | 183 |
| December 4, | 5 | 9 | 1 | - | - | 1 | 4 | 3 | 4 | 2 | 53 | 45 | 98 |
| December 5, | 7 | 8 | 1 | - | - | - | 1 | 1 | 6 | 3 | 47 | 45 | 92 |
| December 6, | 7 | 14 | 2 | 5 | 1 | 1 | 3 | - | 15 | 6 | 80 | 66 | 146 |
| December 7, | 7 | 10 | 7 | 5 | 1 | 3 | 9 | 5 | 18 | 9 | 99 | 80 | 179 |
| | 51 | 60 | 15 | 11 | 3 | 5 | 34 | 15 | 67 | 34 | 474 | 358 | 832 |

### *Squirrels.*

In our report for 1918 we recorded a decided decrease in the numbers of both the red and the gray squirrel. A survey in 1919 revealed that throughout the entire State the scarcity continues. Although in some sections the numbers remain about the same, in most instances the report of lessening numbers is the rule. The only reports of increase which came to our notice were from the west shore of Buzzards Bay and in western Norfolk County. They are extinct on Nantucket. The red squirrels are extinct on Marthas Vineyard, and the grays show no increase. While the food supply on Marthas Vineyard is abundant, the large trees suitable for squirrel homes are lacking in a large portion of the island. Squirrels are hunted there but little, but the red-tailed hawk has frequently been seen to feed them to its young, and these hawks inhabit the large woods which are suitable for squirrel homes.

What the cause of the decrease throughout the State is, no one can say positively; but the failure of the nut crop, due to chestnut blight, was doubtless a large factor in the decrease in the first instance. It is a well-known fact that the squirrels will travel over long distances in quest of food. And while we have no facts to prove the case, it is a fair inference that many of the squirrels have moved into new localities. Especially is this true of those regions where the timber suitable for them has been cut down and where the general conditions have been rendered uncongenial to them.

### *Rabbits and Hares.*

The amount of brood stock in the covers in the spring, it is generally agreed by our deputies, was less than usual, or, in most favored localities, at best, normal.

Everything combined, however, to make a favorable breeding season and about normal numbers were reported this fall.

The rabbit is one of the game animals which thus far has received only a small measure of protection. At the present time we have an open season of four and one-half months, and no bag limit. While it is true that some injury is done by the rabbit, it is nevertheless also true that there are large

areas in the State which can and should support large numbers of rabbits. They not only afford great sport to the hunter, but they are a valuable food supply, and are too great a State asset to be hunted as they are at present. As conditions are to-day in Massachusetts, no animal can stand an open season of four and one-half months and survive. The rabbit is the prey, not only of man, but of owls, foxes, weasels, self-hunting dogs and wood cats. Periodical epidemics of disease, cutting off of covers, hunting with ferrets and night hunting combine to reduce their numbers.

There is no greater sport than following a rabbit with a small pack of well-trained beagles. The increased interest along this line is shown from the following extract of a letter from the New England Beagle Club regarding the number of associations hunting with beagle hounds in the State: —

> At present there are about fifteen clubs and associations holding trials for beagles, which shows a remarkable increase of interest in the sport, as there were but five in existence in 1912.

*White Hares.* — The Commission has purchased trapped hares in Maine (the northern varying hare, or so-called white rabbit) and liberated them in suitable swampy areas in the State for several years past. This year 585 were so liberated. It is too early to predict what will be the results of the stocking.

*Cottontail Rabbits.* — We have had in mind the advisability of liberating a number of Belgian hare bucks in favorable localities to see if they would cross with the cottontail rabbit, in the hope of increasing the size of the wild species. This year 56 Belgian hares were purchased and liberated on Marthas Vineyard. We chose this island because here the experiment could be localized. It is too early to report whether the experiment has been successful.

## Fur-bearing Animals.

Fur-bearing animals as a source of income to the citizens of the Commonwealth are not fully appreciated. With the increasing value of furs it will be advisable to provide a reason-

able protection to certain of the fur-bearing animals, especially the skunk and the muskrat. It is always difficult to state a general proposition that will apply to all parts of the State. For example, some complaint has been made from the cranberry region that much difficulty has been experienced by the muskrats digging through dams which are necessary in cranberry culture, and likewise there would be some opposition by the poultry growers to the protection of the skunk. But, as we have had occasion to say in other parts of our report, there are large areas in the State which could support valuable stocks of wild life where there would be no occasion to emphasize any possible damage to property.

### *Muskrats.*

It was reported to us by a Boston taxidermist that, according to his own experience and that of one of the largest fur buyers of New England, practically no kitten rats were caught in New England during the winter of 1918–19. It would appear that either the rats did not breed, or if they did, the young died. The winter preceding was very severe, and the ice froze so deep that probably 50 per cent of the live muskrats in New England were killed. Notwithstanding the fact that rats were trapped very hard during the winter of 1918–19 on account of the price doubling, he estimates that the winter's catch was not over 40 per cent of the catch of the winter before.

### *Raccoons.*

The enactment this year of a law providing a closed season on raccoons during breeding time was a step in the right direction.

### *Foxes.*

The value of fox pelts continues to advance from year to year, and it is remarkable that in spite of this foxes continue to increase. It is reported by our deputies, with few exceptions, that the amount of trapping done in 1919 exceeded that of the previous year, and many boys took it up. Very high prices for furs have prevailed.

It will be interesting to watch during the near future the extent to which high prices and the increased number of trappers will affect the status of this animal.

## Winter Feeding Work.

### *Upland Birds.*

The winter of 1918–19, in direct contrast to the previous winter, was a very mild, open one. The greater part of the time the ground was bare, and there was an abundance of natural feed in the covers. This made artificial feeding unnecessary, though the district deputies had arrangements perfected to care for the birds should weather conditions make it necessary. Under the circumstances very little feeding was done. Except in times of scarcity it is not good policy to build up feeding stations, for feeding tends to tame, and it is better, both for the health of the birds and to keep them vigorous and wary, to leave them to work for their living in the natural way. It is interesting to note that robins wintered on Nantucket.

Farmers are acquiring the habit of leaving buckwheat and other feed standing for the birds, and the practice is growing, due to the publicity given through the newspapers and the individual work of the district deputies and others interested in bird welfare.

From the storeroom in East Boston 1,200 pounds of feeding material were sent out to individual applicants.

### *Water Fowl.*

There was no occasion to feed the water fowl. The work started last year along this line will be continued when conditions require.

## Bird Enemies.

### *Cats.*

In the data for this year, received from 27 of our deputies, 11 reported that wild hunting house cats were increasing, in many cases very rapidly; 11 reported that the number re-

mained about the same; and only 5 claimed that there are less. One of these five added that in his district the local agent for the Society for the Prevention of Cruelty to Animals had humanely killed 200 cats during the year.

Nearly all say they receive many reports of cats catching birds and rabbits. Two quail were brought to the Marshfield Game Farm by a man who said his cat had brought them to the house. One was brought in during the morning, and later the cat went out and got the other. A deputy reported four cases on his own knowledge, and seven on reports from other persons, where cats had caught birds. In one instance a rabbit nearly as large as the cat itself was the victim. An instance came to the attention of another deputy where a house cat was seen to have five song birds in the course of one day. Another saw a cat which had a young partridge, and another, a full-grown woodcock.

We feel that we should emphasize the statements made in our previous reports relative to the destructiveness of this animal, not only the wild hunting house cat, but likewise the cats maintained throughout the State as household pets. It is elementary that the song birds are friendly and choose to live in and about thickly settled and cultivated areas. It is reasonable to state that few fledglings ever reach the ground in a locality where they are free from this menace.

The time is close at hand when this growing menace must be dealt with if we are to experience the increase in bird life which protective laws should make possible. For the time being a great deal can be done if the owners of house cats will restrain them during the nesting period of the birds, and until the young birds are old enough to fly and take care of themselves. If, during the period from May 15 to August 15, every owner of cats would make it a business proposition to see that their cats were so restrained that they could not do damage to wild life, much of the problem would be solved.

To this end we caused the following poster to be displayed in prominent places throughout the Commonwealth: —

The Commonwealth of Massachusetts

COMMISSIONERS ON FISHERIES AND GAME

William C. Adams,
George H. Graham,
Arthur L. Millett,
*Commissioners.*

## ARE BIRDS WORTH PROTECTING?

The nesting season for the wild birds has arrived, and we again call attention to the necessity of keeping the family cat in control while the eggs are being hatched and the fledglings are helpless, either in the nest or when first on the ground.

It is common knowledge that on the activities of the insect-eating birds depends, in a large measure, the success of the crops and the preservation of the forests.

It is not so well known how enormous are the inroads on the wild birds and young rabbits by the family cat and the abandoned hunting house cat. Often the owners honestly believe their cats to be innocent of killing, because the work is not done where they can see it.

Our observations lead us to believe that 1,000,000 birds are killed annually by cats in Massachusetts.

The Commissioners appeal to every person who owns a cat to make it a personal matter to see that the family pet is not permitted to roam at large in the day or night during this critical period, when the success of the hatch of birds depends on the freedom they have from molestation.

The season extends from May 15 to August 15.

Over the weather conditions, which may reduce the number of the hatch, we have no control; but this other danger can be minimized if every one will make an effort to do his or her part. The birds can be depended on to do theirs.

Every bird lover is asked to see that homeless and wild hunting house cats are humanely killed.

COMMISSIONERS OF FISHERIES AND GAME.

May, 1919.

*Lynx.*

There are indications that lynx are increasing in the State. A Canada lynx weighing 30 pounds and measuring 35 inches from nose to tip of tail was shot just outside the boundaries of the Taunton Reservation by Roland H. Davis of Taunton.

*Starlings.*

From practically all districts came reports of the rapid increase of the starling, larger flocks being found, and greater numbers of nests in the spring. In a few sections they are said to be merely maintaining their numbers. None were seen on Nantucket this year, but on Marthas Vineyard they are present and increasing.

*Hawks, Owls and Other Vermin.*

The abnormal visitation of goshawks in 1917–18 was not repeated the past winter. In most parts of the State the ordinary number of predatory birds was present. Here and there a particular species was more numerous, but no change common to the State or to any considerable section.

*Eagles.*

Eagles are not increasing in numbers to any extent. Some districts show none at all, and where they are found, it is only a pair or so. They are increasing in a small way in the district along the west shore of Buzzards Bay. One pair was observed in Bourne, and one pair near the Lynnfield Reservation. A bald eagle has for several years wintered around the banks of the Merrimack River in Dracut and Methuen, attracted by the sheldrake which also winter in the river. It is not seen in the summer. In the extreme western portion of the State there are a few.

## Reservations.

*Millis Reservation.*

Black ducks bred well in the Millis reservation during 1919, and pheasant and quail have increased. It is an ideal reservation for pheasant, and as intensive farming operations are

carried on within its bounds, this makes it a favorite haunt for quail. Eight quail, 8 wood ducks, 8 black ducks, and 16 mallards were liberated by the Commission. Sportsmen as a rule have not been disposed to trespass, and there have been no violations.

On Oct. 11, 1919, the term of years for which this reservation was established expired, but the landowners have signified their intention of filing a petition for its renewal.

### *Sconticut Neck Reservation, Fairhaven.*

Sixteen mallard ducks were liberated this year on the Sconticut Neck reservation. They have remained within its boundaries and are doing well. There are three or four flocks of quail, and a few squirrels and rabbits, but no partridge or deer have been seen in the reservation for the last five years. The large property owners are making an attempt to exterminate the great number of crows, woodchucks, skunks, muskrats and the few foxes which infest the reservation.

### *Andover Reservation.*

Pheasants, ruffed grouse and rabbits have increased during the past year to a great extent on the Andover reservation, especially the pheasant, which, by overflowing on the outskirts of the closed area, makes good hunting for the sportsmen. Seventy nesting boxes for song and insectivorous birds, all of which were used by the birds in the past season, are maintained by the Andover Natural History Society. Buckwheat and other grains, which were sown here, have a tendency to hold the birds inside of the protected area.

Six white hares, 7 pheasants and 16 mallard ducks were liberated on the reservation by the Commission during the year.

### *Pittsfield Reservation.*

No great amount of time could be given by the district deputy to the Pittsfield reservation, but a certain amount of attention was given it while patrolling the shores of Onota Lake in connection with regular work. Two patches of buckwheat were planted for winter feed, and a small amount of grain distributed.

### *Marshfield Reservation.*

Game birds of all kinds continue to increase, as they have done year by year since the establishment of the Marshfield reservation. Quail are increasing rapidly, and several large coveys were seen in the fall. Pheasants are more numerous, and this is also true of the ruffed grouse. To date several reports of deer have been received, and they also seem to be on the increase.

It is an ideal reservation for ducks, containing fresh water and practically adjoining the ocean. Substantial numbers of black duck and mallards released from the game farm breed in the meadows every year.

Before the opening of the shore bird season the entire reservation, both the outer boundaries and the interior, was posted with new signs, placed so closely that no one could enter except intentionally. The reservation is patrolled very thoroughly during the gunning season by the superintendent of the bird farm. On the opening day for shore bird shooting he examined 50 licenses, and has examined 211 up to November 30, to which date this report is made.

Twelve white hares, 12 pheasants and 16 mallard ducks have been liberated on the reservation during the year.

### *Great Island Reservation, Yarmouth.*

This reservation is not so much a breeding place for ducks as it is a refuge for them after they have hatched. There is good feed and water, they are not molested, and they gather in large numbers and show little fear even when automobiles approach them. Six arrests were made during the year for hunting on this reservation, and all the defendants were convicted and paid fines. Eight quail, 8 pheasants, 16 mallard and 6 black ducks were liberated this year by the Commission.

### *Taunton Reservation.*

In the Taunton reservation the game has increased very satisfactorily during the short time that the area has been closed to hunting. There is a substantial number of pheasants (one

man reported in September that he had seen 10 different broods in a single day), quail are plentiful, and grouse have shown up well this season. Rabbits, hares and gray squirrels, besides insectivorous birds, are numerous. It was near this reservation that the 30-pound lynx mentioned elsewhere in this report was shot this year. Grain and other feed was planted for winter feed for the birds. Six white hares, 14 pheasants and 16 mallard ducks were liberated.

### *Mansfield–Foxborough Reservation.*

This reservation is very accessible to the public, as it may be entered after a seven-minute walk from the Mansfield railroad station, or by stepping across the railroad track at the East Foxborough station. Nevertheless, there has been a notable increase in pheasants, and some of the landowners say there have been more young pheasants on their land this year than ever before. Owing to the nature of the cover it is one of the best reservations in eastern Massachusetts for all kinds of game. Quail and ruffed grouse have increased, while in the small ponds black ducks can be seen at almost any time during the season. It is no uncommon thing to see 7 or more deer, and rabbits are very abundant. An acre of buckwheat was sown and left standing by Walter M. Lowney, and two half-bushels were sown by the district deputy, one in the portion of the reservation in Mansfield, and one in the Foxborough portion. There have been only two small fires on the reservation during the year. The law has been well observed.

Six white hares, 7 young pheasants and 16 mallard ducks were liberated by the Commission this year.

### *Marblehead Neck Reservation.*

There is little to report in regard to the Marblehead reservation. No changes have taken place during the past season. It is so much built up with summer residences that its chief value is as a stopping place for the early migration of song, insectivorous and shore birds. Though the Neck is nearly encircled with homes, it is interesting to note that a number of pheas-

A Canada lynx weighing 30 pounds and measuring 35 inches from nose to tip of tail. Shot just outside the boundaries of the Taunton Reservation.

ants breed in the open area in the center. It is the best place in that district for the observation of these species by bird students.

*Hingham Reservation.*

The birds wintered well on the Hingham reservation. Quail thrive here, and they were very plentiful this spring. A person standing anywhere on the reservation could hear three or more calling almost any time. Ducks, squirrels and pheasants are coming along well, and rabbits have shown up this year. The liberated mallards on the ponds serve as decoys, and the black ducks have used the reservation in good numbers.

Vermin is more plentiful than it should be for the welfare of wild life. This is specially true of cats.

The reservation is well posted, but as the State highway runs through it there is a great temptation to hunters to take a shot from an automobile while driving through. Six hunters have been in court this year, charged with hunting on a State reservation. Two fines of $25 and four of $3 each were imposed, and all paid except one, which was appealed.

This is an excellent example of what can be done on an area sprinkled with residents and which has a large summer population. Eleven pheasants, 16 mallard, 10 wood and 10 black ducks were liberated on the reservation during the year.

*Bare Hill Reservation, Harvard.*

The Bare Hill reservation covers over 1,700 acres. In general, the ground is irregular, consisting of a system of knolls and rocky ridges, interspersed by swamp and rolling farm land. The greater part is wooded to some extent. Natural fruits, berries and nuts grow in abundance, and there are several old abandoned apple orchards.

Bare Hill Pond, one of the largest lakes in this section, occupies the center of the reservation. Its upper end, consisting of several large, shallow, weedy bays, bordered by swale, furnishes splendid breeding, feeding and nesting grounds for water fowl.

The desirable wild life at present inhabiting the reservation is disappointing in point of numbers. Gray squirrels have in-

creased to a marked extent. It is baffling to note the slight increase of grouse. The few pheasants located have not multiplied. No quail have ever been seen on the reservation. Rabbits are barely holding their own despite the fact that there are hundreds of acres of suitable cover for them. Water fowl have resorted to the lake in greater numbers this fall than for many years. The few wood duck which usually have been reared every year along Bowers Brook were not seen this fall.

The unsatisfactory rate of increase among the game birds and rabbits may be safely attributed to the increase of vermin, which appears very numerous. Steps have been taken to improve this condition.

Seven pheasants and 16 mallard ducks were liberated during the year by the Commission.

### *Tyngsborough Reservation.*

No violations of the game laws have been committed on the Tyngsborough reservation during the year, and none of the owners complained of trespassers or of depredations to property, though such have occurred in neighboring camps. Pheasants are very numerous, but ruffed grouse are scarce. They are entirely missing from a grove of pine trees which was formerly a favorite haunt.

Suet cages and feeding stations, maintained by one of the landowners for the small winter birds, are well patronized. During the summer and fall work has been going on over a large portion of the southern end of this reservation, converting it into a golf course.

Eight pheasant chicks from the Marshfield Game Farm were liberated.

### *Lynnfield Reservation.*

The Lynnfield reservation, which includes Suntaug Lake, is an exceedingly favorable location for the propagation of birds. It has good cover and water, and mallard ducks liberated there from the estate of the late J. B. Pierce have bred in large numbers. In June of 1919 the district deputy saw 40 young mallard ducks. It is estimated that over 200 mallard ducks

use the lake, and at times numbers of black ducks are among them. Quail (some of which were liberated there in 1917) were heard this season, and pheasants are thriving.

Seven pheasants and 16 mallard ducks have been liberated by the Commission during the year.

*Hubbardston Reservation.*

Ruffed grouse, deer, white hares, coney rabbits and gray squirrels are increasing on the Hubbardston reservation.

The second three-year period for which this reservation was established expired Oct. 18, 1919. The re-establishment of this reservation is under consideration, and it is expected that the matter will be disposed of early in the coming year.

*New Reservations under Chapter 410, Acts of 1911.*

One new reservation, to be known as the Randolph reservation, was established, for a term of five years from June 21, 1919.

It is located in the extreme northeastern part of the town of Randolph, bounded on the west and north sides by the Blue Hill reservation. The other boundaries are clearly defined by highways.

The tract includes approximately 650 acres of land, quite hilly and well dotted with large rocks and ledges. Though the entire reservation is well crossed with wood-roads, making all parts accessible by carriage, there are no thoroughfares, traveled roads or public ways within the lot, and no farms or buildings other than a small summer camp.

The greater part of the reservation is covered with a young growth of scrub oaks, with tall timber standing here and there. There are a number of pine lots, well covered with large pines and a small growth of young hemlock, making excellent cover for ruffed grouse, of which there are good numbers. There is no great amount of suitable cover for pheasants and quail on this area. Still, quail frequented it to some extent in past years, but none have been seen for the last two years. This summer, however, the caretaker saw two good bunches. There are only two open or mowing fields, and these have passed to almost the stage of pasture

land. A number of blueberry swamps and bogs furnish an excellent cover for white hares and rabbits. The latter are in good numbers on the reservation. There are also a few gray squirrels. Foxes are quite numerous. The reservation will be patrolled regularly during the hunting season by the caretaker of the property of the principal landowner.

### *Marthas Vineyard Reservation.*

During the early part of the year (from Dec. 1, 1918, to the middle of the following March) the trapping of vermin, and patrol work for the enforcement of the laws protecting the heath hen, fully occupied the superintendent's time.

The weather during this period was very mild, very little snow fell, and natural food was abundant over most of the island. This prevented an accurate estimate of the number of heath hens, for the reason that the birds remained scattered. About 100 were seen there on January 7, and on February 21, 75 were seen feeding on the high ground.

*Breeding Season.* — Through inquiries in the different parts of the island, and from his own observations, the superintendent's best estimate of the number of birds on the island in the spring was 165. It is impossible, of course, to get an exact census. During the nesting season the weather was quite favorable, and it is probable that many broods hatched. More broods were seen by the superintendent than the previous year. The summer was rainy, but by that time the young had reached a size at which they were able to stand the dampness. Eight broods of heath hens were counted on or near the reservation, and several other broods were reported in various parts of the island. One found by the superintendent near Oak Bluffs consisted of 11 chicks. The average brood was 5 chicks.

*Cultivation of Land.* — Thirty-seven and one-half acres of land were under cultivation during the year. Six acres of corn were planted, but owing to the damage to the growing seed by rats, a smaller crop was raised than had been expected. Eighteen acres were seeded to hay and oats, and the latter cut for feed. In the fall 5 more acres were planted to hay. An acre of carrots yielded 65 bushels of food for the horses.

The 7 acres of buckwheat for the heath hens grew well, but the half acre of sunflowers, planted twice, was each time dug up and destroyed by rats. Some sunflowers came up among the corn from last year's seed, reached maturity, and were fed upon in the fall by goldfinches and chickadees, who show a great partiality for this kind of feed.

*Vermin.* — Nineteen cats were killed on the reservation. Again we must comment on this situation. This reservation is located 4 miles from the nearest town, and there is no house within 2½ miles where it is likely that a cat would be harbored. We do not believe that this area is any exception, and feel convinced that not only Marthas Vineyard but vast areas in other parts of the State are continually combed over by house cats. If 19 of these animals were disposed of on this reservation it is not difficult to visualize what would be taking place in respect to our wild life over the more populated regions of our State. Hawks were very numerous during the summer and fall of 1919, and on several occasions were bold enough to kill barnyard fowl near the house. Thirty-five were shot and trapped in the course of the year.

A very great increase in rats was noted, not only on the reservation, but in all sections of the island, and many farmers reported large losses from this pest. A vigorous warfare was maintained against them on the reservation, where they raided the newly planted corn field and even dug up tarred seed. Two hundred and fifty-eight were killed and counted, but there is reason to believe that many more were killed by poison and not discovered. In a period of thirty-six days the superintendent killed and counted 103, aside from those killed by poison that were not found. It was noticed that thereafter but little damage was done. Sufficient corn for the heath hens was raised in spite of the rats.

*Fires.* — There was an entire absence of fires on or near the reservation.

*Fall Conditions.* — Flocks of heath hens were reported in the fall from widely separated parts of the island, and the superintendent himself saw several flocks in widely separated localities, averaging 9 birds in a flock. This indicates that the birds are widely scattered. For this condition the fire of

1916 is no doubt partly responsible. The heath hens at that time were driven to the edges of the plain country, notably to the northeast, east and south. As it was nesting time, and there was no cover on the plain, they were obliged to nest on the outskirts of the fire area, and thus they are found to-day around Katama, Edgartown Great Pond, and other ponds as one works west, and around Sengegantacket Pond. The land around these ponds was not burned over to any great extent, food was abundant, and therefore the young remained in the places where they were hatched. The heath hens are once more gaining ground, and no doubt will continue to do so with protection from gunners and vermin and freedom from the greatest menace, — fire.

*Myles Standish State Forest.*

This was the first full year of work on the Myles Standish State Forest (so far as fish and game operations were concerned), and it was a satisfactory one, both in the increase of wild life and in the destruction of enemies to the latter.

Ruffed grouse, which were very scarce when the reservation was taken in hand, have made a marked increase, and from 6 to a dozen birds could be seen in a day by the superintendent when on patrol work. Quail are not very numerous, and only two bevies were on the reservation during the summer, which may perhaps be due in part to the small amount of tilled land. The superintendent is attempting to hold one of these covies on the reservation by feeding. Rabbits are more numerous. Deer, too, are increasing and are constantly seen around the buildings and tramping over the nursery. In fact, they are a detriment to the young pines. Thirteen were seen in one day the week after the open season in December, 1918. Black ducks are very plentiful, but mallards do not stop to any great extent. A few have been seen, but even those reared on the reservation went away soon after liberation. Wood ducks are quite numerous, but there were few teal. Pheasants are seen quite frequently, and cocks could be heard all around the buildings in the spring. Three young broods have been seen which were raised by the pheasants reared and liberated on the reservation in 1918.

Through the efforts of the superintendent substantial inroads were made in the enemies to bird and animal life. The toll up to November 20 was —

| | | | |
|---|---|---|---|
| Foxes, | 17 | Rats, | 30 |
| Cats, | 8 | Great horned owls, | 4 |
| Skunks, | 27 | Red-tailed hawks, | 6 |
| Weasels, | 5 | Sharp-shinned hawk, | 1 |
| Snapping turtle, | 1 | | |

The propagation of pheasants and mallard ducks was continued in a small way. Pheasant eggs, taken from stock on the reservation, were set under bantams. Seven bantams raised an average of 8 chicks each, and 1 Rhode Island Red hatched 15 and raised 12. Following last year's method, the chicks were not penned up, but allowed to roam at large when two days old. This caused them to thrive and gave good vitality. Two adult pheasants, which were set in captivity, were liberated with their 12 young. Two lots of eggs from the Wilbraham Game Farm were hatched and 74 chicks liberated. Fifty-one mallard ducks were raised and liberated.

Japanese barnyard grass, rye and buckwheat were planted as feed for the wild birds. Wild rice was planted in the most suitable places, but did not thrive in the still waters of the ponds on the reservation. Probably wild celery is more suitable for these waters, and will be tried another year. The wild ducks were fed during the winter with rice feed.

Seven pheasants, 16 mallard, 15 black and 30 wood ducks from the game farms were liberated on the Myles Standish State Forest in addition to the birds reared there.

The reservation has been patrolled early and late, the various parts being covered at irregular periods so that the deputy should not be expected to be in any particular place at regular times. No cases have been taken to court.

### *Moose Hill Bird Sanctuary.*

The Moose Hill Bird Sanctuary at Sharon was established in May, 1918, by the Massachusetts Audubon Society as a model wild-life sanctuary where methods in bird protection and all matters pertaining to bird welfare might be studied

and practically demonstrated. This area was already a State reservation, being occupied by our Board under chapter 178, Acts of 1902, "for the making of scientific investigations upon the propagation of all useful wild birds and quadrupeds." By special arrangement with the Audubon Society and this Commission the sanctuary has for the past year been carried on jointly by the two organizations, with a resident superintendent.

The sanctuary consists of a tract of approximately 225 acres on the hills of Sharon, 25 miles south of Boston. This tract seems especially well situated for demonstration purposes and experimental work, being sufficiently isolated to allow for its maintenance under wild conditions, yet easily reached by visiting parties. About a mile southeast of the property lies the well-known Lake Massapoag, and 2½ miles southwest is Foxborough Pond, the headwaters of the Neponset River, while a few miles to the north begins that broad expanse of open marsh known as "the Canton Meadows."

Within this area are cedar, maple and alder swamps; open meadowland; cultivated and half-wild fields and orchards; and forest areas of mixed growth. There is a small woodland pond near the center of the tract, and an artificial duck pond by the roadside near the farmhouse.

Within this area during the past year more than 100 different kinds of birds have been observed. Sixty-three species nested here. Seventy-five nests have been under observation during the summer, and many interesting facts concerning them have been brought out. Repeated observations of our bird population during the breeding season have resulted in an estimate of 300 pairs of nesting birds within the sanctuary grounds, and it is believed that about 1,200 young birds were raised here this season. Several of these are of unusual occurrence in this locality, or otherwise of special interest.

Woodcock sang nightly about the orchards and alder swamps during the mating season, and at least two pairs probably nested on the grounds. Ruffed grouse have been plentiful here, and bobwhites have been seen throughout the season, though not in abundance.

About 50 house wrens were successfully raised in the bird boxes, and probably a greater number of tree swallows. The

hairy woodpecker, the solitary vireo and the hermit thrush, — birds which ordinarily have a more northerly breeding range, — all nested within the sanctuary grounds.

Studying, identifying and card-cataloguing these various species, experimenting with feeding and nesting devices, and keeping records of observations made are part of the daily work of the superintendent, whose headquarters are in the old farmhouse on the property, situated on Moose Hill Street, 2 miles west of the Sharon depot. In his office are kept on file specially designed cards recording information on all birds nesting in or visiting the grounds. This study and observation is also extended to cover the plant growth and other wild life to be found within the sanctuary, and already about a hundred different trees, shrubs and vines, many rare ferns, and over 300 varieties of wild flowers have been identified here. Aside from being of vital interest in connection with the birds, these records form a valuable compendium of information for the visiting student.

In this room — which is a combined office and museum room — may also be found exhibits of bird work; bulletins — both State and national — regarding methods of attracting and protecting birds; exhibits of mounted birds and nests; photographs and exhibits of destructive insect work; a collection of 800 birds' eggs; a miscellaneous collection of insects numbering about 400 specimens; a compound microscope for study; and a library of more than 200 volumes on natural history and the sciences, all of which is the property of the superintendent and is placed here for the benefit of the visiting public.

Many attractive trails have been laid out, named and marked, and the grounds are also being mapped and charted with a view to more intensive study and to show at a glance the character of the ground and where nests and bird boxes are located.

Visitors may examine and compare the various types of bird boxes and feeding devices, and observe them in actual use. Many of these, as well as bird books, charts and educational leaflets, may be purchased here. They may also receive advice upon any problems in bird work. It is planned to keep

down destructive birds and animals only where necessary, so that these also may be studied in their natural environment.

Regular "bird walks," under the direction of the superintendent, were conducted here twice weekly during the spring and early summer. A special "bird day" was also held on May 17, attended by about 200 people, coming from 40 different cities and towns throughout the State.

The Moose Hill Bird Sanctuary is becoming widely known. During the past year about 1,300 visitors were entertained who registered from 77 cities and towns in Massachusetts, and from 13 States and provinces.

The sanctuary grounds have been posted with specially designed posters which have been effective in maintaining safety for the birds.

Food of various kinds has been kept out for the birds throughout the entire year, and experiments are being made with wild fruits, weed seeds and various grains, with the hope of inducing other species to lengthen their stay with us.

In addition to the work mentioned, patrolling of surrounding woodland areas, about 10 square miles considered as a tentative State reservation, has been undertaken.

With special relation to the game birds, 10 wood ducks, 10 black ducks and 18 pheasants have been received. Some of these have been liberated, and others kept for breeding and exhibition purposes.

## INLAND FISHERIES.

### Fishing License Law.

Probably the most important and far-reaching piece of legislation in respect to fresh-water fishing enacted in many years is the extension to fishermen of the license act.

The provisions of the new law, in so far as they relate to fishing, are as follows: —

1. The act took effect Oct. 10, 1919.

2. It provides that all persons must have a license to fish in any inland waters of the Commonwealth stocked by the Commissioners on Fisheries and Game since Jan. 1, 1910, with the following exceptions: —

(*a*) Any legal resident of Massachusetts may fish without a license in any inland waters bordered by land owned by him.

(*b*) Minors under the age of eighteen, and women, require no license to fish.

3. Licenses are to be issued only by city and town clerks, except that any person appointed as a deputy registrar by a city or town clerk may issue fishing licenses only.

4. Fees for licenses are as follows: —

| | |
|---|---|
| Resident citizen, combination hunting and fishing license, | $1 00 |
| Resident citizen, fishing only, | 50 |
| Non-resident citizen, combination hunting and fishing license, | 10 00 |
| Non-resident citizen, fishing only, | 1 00 |
| Non-resident property owner to value of $500, and non-resident club member (providing the club owns taxable property equal to $500 for each member), same fees as are charged resident citizens if the State from which non-resident comes extends similar privileges. | |
| Alien owning $500 real estate, combination hunting and fishing license, | 15 00 |
| Alien owning $500 real estate, fishing only, | 1 00 |

*No other alien can secure a license to hunt or fish.*

5. All city and town clerks are to retain a fee of 15 cents for each license issued.

6. A non-resident, properly licensed to fish, may carry from

the Commonwealth into any other State according similar privileges 10 pounds of brook trout in one calendar year.

7. Licenses are forfeited on conviction of violation of the fish and game laws, or any provisions of the license act.

8. If licenses are lost, duplicates (without cost) can be secured only from the office of the Commissioners on Fisheries and Game on presentation of a sworn statement setting forth the facts of the loss. Town and city clerks are not authorized to issue duplicates, though they may issue a new license on payment of the regular fee.

Pamphlets giving a list of waters stocked by the Fish and Game Commission since Jan. 1, 1910, were prepared and distributed.

The new law has a great deal to commend it, and works no hardship to any one, since its operation does not extend to women, minors or landowners. The fishermen themselves have shown a disposition to be willing to pay their share of the expense of maintaining their sport, in the same way that the gunners have done for theirs in the past, and the revenue should be substantial. The principle involved is not a new one. Indeed, in this respect Massachusetts has lagged far behind many other States of the Union, in 24 of which fishing license laws applying to one class or another of fishermen are already in successful operation.

In its application to the part of the alien population which has not yet achieved citizenship the effect of the new law will be far-reaching. It will be noted that no alien may secure a license to fish (or hunt) unless he owns real estate in this Commonwealth to the taxable amount of $500. The free fishing privilege which the alien population has hitherto enjoyed is one of the big factors which in the past has been responsible for the rapid depletion of the fish in our ponds and streams. Aliens have been permitted to fish at will, and no limit has been placed on the quantity of some of our common food fishes which might be taken. They have small conception of the principles of conservation, and in most cases no conscience in the matter of taking fish by illegal methods. As a result in many instances our waters have been literally stripped of fish, and nothing in the law has prevented it. The restriction

placed on the alien by the new law is an entirely proper one. It is eminently fair that he should be prevented from exploiting the natural resources of the State until he assumes the obligations of citizenship. It serves to hold him in check until he is familiar with our laws and can understand that this is not a country to be stripped of its wild life with no thought of the future.

### Trout.

The trout fishing season opened with the streams in excellent condition. The water was not unduly high, and temperature conditions were right. In most of the streams and ponds normal conditions prevailed. Throughout the trout districts it was pretty uniformly reported as being the best season in years, with good catches and heavier fish.

## Chinook Salmon.

### *In the Merrimack River.*

We have followed our program of the past three years of planting Chinook salmon fingerlings in the Shawsheen River and its tributaries, with a view to stocking the Merrimack River with these fish. During the past year 278,500 fingerlings were so distributed.

### *In Inland Waters.*

During the year 3 to 6 inch Chinook salmon were planted in the following ponds: —

| | |
|---|---|
| Peters Pond, Sandwich, | 10,200 |
| Cliff Pond, Brewster, | 5,000 |
| Bloody Pond, Plymouth, | 4,100 |
| Neck Pond, Barnstable, | 3,400 |
| Spectacle Pond, Lancaster, | 5,160 |
| Onota Lake, Pittsfield, | 9,900 |
| Long Pond, Plymouth, | 9,900 |
| Great Pond, Otis, | 10,000 |
| Big Alum Pond, Sturbridge, | 10,000 |
| Quarry pits, Gloucester, | 2,000 |
| Norwich Lake, Huntington, | 5,200 |

Between 1913 and 1919 we have stocked 15 of the great ponds in the State with Chinook salmon of this size. The fish have been

distributed each year beginning about September 15. The total number planted amounts to 359,585. The salmon have shown up in substantial numbers in only one pond, — Long Pond, Plymouth. There are some prospects in Peters Pond, Sandwich, and Cliff Pond, Brewster, where a few fish have been taken.

Peters Pond, Sandwich, was stocked in 1917, 1918 and 1919 with a total of 28,200 fingerlings. Cliff Pond, Brewster, has been stocked from 1914 to 1919 with a total of 42,275 fingerlings. Neck Pond in Barnstable, Spectacle Pond in Lancaster, Great Pond in Otis, the Quarry pits in Rockport and Norwich Lake in Huntington were stocked this year for the first time.

In view of the fact that the fish have not appeared to thrive we have discontinued stocking the following ponds: Lake Garfield in Monterey, Long Pond in Wellfleet, Stockbridge Bowl in Stockbridge, and Lake Quinsigamond in Worcester.

Various explanations have been advanced as to the reasons why these salmon have not taken hold in some of the ponds which we have ceased to stock, and in other ponds which we are still stocking. Some of the ponds have outlets which are screened, and the theory has been advanced that the screens are too coarse and the young fish have passed through them; also that some of the ponds have had too large a supply of pickerel. Lake Quinsigamond, Long Pond, Cliff Pond and Onota Lake have a substantial supply of smelt in them. All of the ponds stocked are either landlocked or have screened outlets. In this connection the following questionnaire, setting forth the opinions of Dr. W. H. Thayer of New Bedford, will be of interest: —

Q. Are there any changes in our method of propagation that you would suggest? A. I believe fully that the pickerel is much more the enemy of the small salmon than the bass, and I am convinced, in my own mind, that the placing of the salmon, beginning a month earlier than is now the custom, would be beneficial. (In all my fishing I have seen few bass on the shore after September 15. This fall, the last of October, I saw pickerel chasing the freshly introduced salmon at night in Long Pond.) Either that, or introducing the salmon at the latest possible moment, letting them grow as large as possible before placing in the ponds. Ponds having weedy shores where small pickerel live (fish that I call string pickerel, never growing over 10 or 12 inches long) are particularly dangerous to the small salmon.

Q. Does there appear to be any explanation in your mind as to why these fish have not shown up in all of the other ponds which we have stocked? A. The pickerel question, to my mind, partly answers this question also, and I believe that a study of the vegetation on the bottom of the pond, which is very important to small fish, furnishing hiding places their first year, and the microscopic life of the water itself, is the only explanation.

Q. What is your opinion of the probable permanent success of attempting to stock our ponds with this fish? (The great ponds which we have stocked will average about 200 acres in size, and this is about the average size of our largest ponds, with the exception probably of two or three which are quite large but very shallow.) A. I think that the ultimate success of the Chinook salmon in our great ponds is assured. After studying these fish carefully for three years I find them different in habits and characteristics from any fish I have seen. Still, I believe that a study of Long Pond, with possible experiments in other ponds, will eventually provide a favorable answer.

Q. Is there any other species of salmon which you would consider more adapted to this scheme of landlocking in fresh-water ponds than the Chinook? A. The steelhead of the Pacific coast. This is, of course, a salmon and not a char, and is superior in every way to all the Pacific fish; a free riser to the fly, it is ideal; wonderful size, and does not die after spawning. I would like to see the *fontinalis* of Lake Superior introduced into some of our ponds. This fish, living among thousands of European pike and Mackinaw trout, should thrive here. The squaretail of Sebago is yearly increased even in this, one of the greatest of all bass lakes.

Q. In your opinion is there any species of trout or salmon which can survive in a pond where there is a substantial number of bass and at least a scattering of pickerel? A. I believe the possibilities of the brown trout in waters not fitted for the *fontinalis* (that is, the great ponds) are at present undreamed of. In European waters these fish provide wonderful fishing, and should receive more consideration where the stocking of our great ponds is concerned.

In Long Pond, Plymouth, it is reported that at least 50 salmon were taken by anglers on the opening day, April 1. Most of these were taken trolling, although a few were taken with the use of a small paper minnow casting, as in fly fishing. The two largest weighed nearly 10 pounds.

Mr. E. L. Bassett reports: —

During April and May probably 1,000 fish were caught, weighing from $2\frac{1}{2}$ to 4 pounds, but during the summer only a few fish were caught, about 3-pound fish. In the fall (September and October) quite a lot of fish were

caught about the same weight. Small salmon the last month running 10 to 12 inches were biting very freely, and often boats would catch 40 or 50 of these small fish, putting them back, so it made it hard work to get the bait out for any length of time, as these small fish would take the bait as soon as it struck the water.

Dr. W. H. Thayer of New Bedford reports: —

Last spring I caught perhaps 50 salmon, mostly on shrimp, weighing from 2 to 4½ pounds each. . . . In the fall I caught large numbers of one-half pound fish, and very few went to 2 pounds. . . . I know of one man who caught between 40 and 50 salmon weighing from 2 to 4 pounds in August and the first half of September with shrimp, surface fishing, in the big cove above the Boy Scouts camp on the west shore. After the crowd found this out and gathered there, few big fish were taken, but hundreds of small fish were caught. Where the 4-pounders of last spring were I do not know; also I saw only three fish of the thousands seen a year ago, — fish weighing from 10 to 12 pounds.

At the close of the season Mr. Edward E. Bassett reported as follows: —

I think the large ones have all been caught up this last season. I think that there were as many as 800 caught. I know of 400 caught down my end of the pond. They weighed from 2 to 3 pounds. There were only two large ones caught that I know of. Ernest Bassett caught one of 6 pounds, and a man from Revere one of 8 pounds. . . . The last two months of the season a very few salmon were caught. There were plenty of them 10 and 11 inches long. Some said the water was alive with them, and one man caught 70 and one caught 20 in one hour. . . . They put them all back. I have not heard of any one finding a dead salmon on the shore of the pond.

Mr. Homer H. Hervey of New Bedford states: —

A few other fish weighing 4 and 5 pounds each were taken, but the great majority ranged in weight from 1½ to 2½ pounds. During the spring and summer a few salmon were taken. I have a report of one of 6 and one of 5 pounds taken early in May. But all the rest would hardly average 2 pounds. The salmon gradually disappeared toward the fall, and during the last two weeks in October no salmon at all were caught. During the whole summer the pond was alive with small parr weighing from 4 to 6 ounces each. . . . These small parr rose freely to the fly, but were too small to afford much sport, and of course were below the legal size.

Reporting later, Mr. Hervey said: —

During the summer and fall of 1919 about 100 fish of the average weight of 2 pounds were caught. . . . There were also several hundred small fish taken weighing from one-quarter to one-half pound each. These appeared to be very hungry, and would snatch eagerly at anything that looked like food on the surface of the pond.

There are large numbers of suckers in this pond, and it was believed that seining some of them would be beneficial, in that they eat large quantities of smelt spawn. On the 9th of April 500 large suckers were taken out. Two fishermen of Plymouth did the work, using a seine of 75 fathoms which was 18 feet in depth.

The supply of smelt appears to be decreasing. At the end of the season Mr. Edward E. Bassett reported: —

In regard to the smelt in Long Pond I think that the salmon and suckers have eaten them about all up. I do not think that the bass eats them. The pickerel are about gone out of the pond. I have not seen but two for two years. Why I do not think the bass and other fish eat them is because in the thirty-four years that I have fished Long Pond I have seen a smelt in only two fish, and in that time I have cleaned hundreds of them. . . . I can tell you next March if the smelt are all gone.

Mr. Hervey states: —

During the summer no schools of smelt were seen at the surface anywhere, and in the fall those smelt came to the shore the way they have done for the last few years. All indications point to the fact that the smelt are disappearing in this pond.

With reference to the policy of stocking Long Pond and the other ponds in the future, the consensus of opinion appears to be that these ponds have been overstocked, and that it will be advisable to plant fewer fish in them for some time.

### Large-mouth and Small-mouth Bass.

The bass is increasing in popularity, as is evidenced by the demands for stock from all parts of the State. Its game qualities are unquestioned, and its edible qualities are good. As an introduced species it has probably taken hold better than any

other. Moreover, it has the advantage of being a satisfactory breeder, and will hold its own, and better, with the pickerel. In view of the fact that most of our ponds contain either pickerel or bass, or both species, it seems logical to increase the propagation of them. The report of the past year's fishing is one of the most favorable ever received, indicating that our efforts in stocking, though limited, have begun to show results.

### Pickerel.

Despite the many undesirable qualities of the pickerel, it is, nevertheless, a popular fish throughout the State. It affords the bulk of the sport of winter fishing. Its popularity may be due to the fact that it is one of the few species that can be found in comparative abundance in our waters; but, nevertheless, there is something fascinating in the sport which appeals to a large number of our fishermen. The edible qualities of the pickerel are unquestioned, and it annually contributes substantially toward the food supply received from our natural resources.

The time has come, however, when this species, as well as all others, must have increased protection. At the last session of the Legislature we advocated stopping the sale of pickerel, and limiting the catch, but no action was taken. The time has gone by when any individual should be permitted to commercially fish any of our great ponds; and, moreover, a catch limit should be established insuring a day's sport, but not permitting the fish to be taken, as they are to-day, in unlimited numbers. The season should be shortened to the extent of cutting out the late winter fishing, for many fish now taken after January 1 are found to be full of spawn.

Reports seem to indicate that pickerel fishing in the year past was not as good as usual. In some localities this may have been due to the mild winter and the more limited opportunities to fish through the ice, but the general opinion is that the number of fish is falling off in most parts of the State.

Early in the summer one of the deputies salvaged about 200 fingerling pickerel in the setbacks of the Connecticut River, and placed them in the Oxbow.

### Pike Perch.

While pike perch are being taken in good numbers and of a good size in some ponds, they are confined to a few scattering localities. A general survey of the State shows that the ponds which were stocked a number of years ago with pike perch are still producing a fair supply, while the more recently stocked ponds are not yet yielding many fish. Pike perch are well established in the Connecticut River and its tributaries.

In the belief that this is a very valuable food fish the Commission is making special efforts to rear and distribute pike perch in good numbers each year. They are not present in sufficient numbers, however, to furnish a proper supply of eggs for our work in artificial propagation, and we still have to depend on securing eggs from the spawning grounds around Lake Champlain and Missisquoi Bay in Vermont.

Negotiations were started during the winter of 1918, with Commissioner Linus Leavens of Vermont, looking to the establishment of a field station to be operated jointly by the two States, expenses and eggs to be shared equally. Commissioner Leavens selected West Milton, Vt., on the Lamoille River, as the site for the operations of the joint crew, and in December, in company with a representative of the Vermont commission, one of our superintendents inspected the grounds and perfected details for the work in the spring.

The United States Bureau of Fisheries takes its supply of eggs at Swanton, Vt., on Missisquoi Bay. It was agreed between the United States and the Vermont officials that in case the fish appeared in one locality, but not in the other, operations would be carried on by both, at whichever place the fish might happen to be.

On April 16 word was received from Vermont that no pike perch had been running at West Milton, though at Swanton the United States Bureau of Fisheries had been taking them in good numbers. Commissioner Leavens decided to depend on Swanton rather than to risk a failure at West Milton. Our superintendent and assistant went to Swanton on April 22, where they were allowed the use of the camp and equipment of the United States Bureau of Fisheries. In return for the

courtesy, our men helped the United States Bureau of Fisheries crew in taking eggs. On arrival our men found the big run over, but by April 25 they were able to ship 50 quarts, or 7,500,000 eggs, and some were on hand that were too green to ship. The weather was extremely cold, with snow, and the wind blowing a gale. This made fishing impossible until the weather settled. On April 27 our superintendent, learning that the fish were running in the Lamoille River, went on and joined the Vermont men at the West Milton location, leaving his assistants to finish up the work at Swanton and follow him. About 7 quarts more of eggs were shipped from Swanton. At West Milton Superintendent Monroe found that the Vermont crew had caught up and were holding 125 females and 250 males to ripen. The fish came along slowly as the snow water served to hold them back. Our crew took eggs and the Vermont crew did the seining for fish, our men helping when not otherwise occupied. Conditions were not very favorable for seining, as the river bottom was covered with logs and limbs of trees brought down by the spring freshets.

Three hundred and fifty females and 500 males were secured and placed in crates to ripen. The eggs taken were sent by express to Palmer. An additional 60 quarts were taken at this location. By May 8 the Palmer Hatchery had received all the pike eggs it could handle, and our men were recalled. The total amount of eggs collected by our men was 117 quarts.

The eggs shipped to the Palmer Hatchery were in the green, not the eyed, stage. The green eggs transport better, and good results have been secured from them in the past. However, to guard against any possibility of unusual losses, our superintendent filed a request with the officials for a consignment of eyed eggs. Out of a shipment of eyed eggs received, 1,500,000 eggs were added to the above. From all the eggs received there were hatched and distributed 8,240,000 fry.

The pike perch season this year was an unusual one. The fish came three weeks earlier than usual at Swanton, and on the Lamoille River the season was two weeks earlier. The weather conditions were very unfavorable, and all of the crews worked under unusual handicaps.

The Board takes this opportunity to acknowledge the courte-

sies received from the officials of the United States Bureau of Fisheries, and of the Vermont commission, in loaning equipment and in giving our men the use of their camps and buildings.

## White Perch.

White perch are increasing in many of the inland stocked ponds. Usually several years elapse after a pond has been stocked before results begin to be evident. During the past year white perch have shown up well in the ponds at Falmouth; Lake Archer, Wrentham; Lake Lashaway, East Brookfield; some in Russell Pond; Congamond Lakes, Southwick; Hampton Ponds, Westfield; Hardwick Pond, Hardwick; and Gravel Pond, Hamilton, the first, to speak of, since stocking a few years ago. They have shown up very well also this season at Watuppa Lakes, and this year they are being taken in Forge Pond, in Westford and Littleton. They were abundant in this pond up to some five years ago, but during 1914 to 1918 very few were taken, and many white perch came ashore dead, believed to have died of disease. Those being taken now are not so large as formerly, averaging one-half to three-quarters of a pound against 1 pound previously.

The white perch salvage work was begun on March 13 at Lake Tashmoo, Vineyard Haven, with a crew of three men. The gear consisted of one large 16-foot seine boat; one 14 foot skiff equipped with an Evinrude outboard motor; one seine 60 fathoms long and 3 fathoms deep in the bunt, three-quarters inch mesh; four fyke traps, 9 feet long, 4-foot hoops, 40-foot wings and 7 holding pockets 3 by 4 by 9 feet, capable of holding 1,000 fish each; with considerable smaller gear.

The weather was very unfavorable all through March and the early part of April, the temperature often getting as low as 25°, and on some occasions down to 17°. This low temperature was accompanied by very high winds which made seining difficult, as the fish would seek the deep water. After a cold north wind the men could seine the spring holes at the head of the pond in 25 feet of water with fair success.

A new method was tried of setting fyke traps in deep water (20 feet) in the early spring, with fair success. The perch do not begin to work into shallow water until the temperature of

the water in the pond reaches 48° or 50°, when the alewives come around the shallow water to spawn and the perch in large numbers follow them in, eating the spawn as fast as the herring deposit it. At such times the run of perch into the fykes is very good. They were fairly abundant, running in size from 2 to 5 inches, but not so numerous as they were in 1918 at the same pond.

The same methods of holding the fish for shipment were used as last year, — staking the pockets out in 30 inches of water. However, when the wind beat across the pond into the pockets, the rough water and cold combined tired the fish and many died. Those that survived did not ride well during transportation to their destinations. This will be overcome another season by building a wooden breakwater around the holding pockets.

Shipment was begun on March 18 and continued every week day without interruption until May 29. There were 113,000 distributed to public waters, and 10,600 to the Webster selectmen for Webster Lake, under the usual arrangement by which our men catch the fish and the selectmen pay the expenses. This made a total of 123,600 white perch distributed in all, some 56,750 in excess of last year. Trial was made of a water pump for aërating the fish in transit, with excellent results.

### Smelt.

#### *Salt-water Smelt.*

The taking of salt-water smelt spawn is now a regular feature of the year's routine. This year a three-year lease was taken of the land at the site of the smelt operations, together with the right to use the brook within the leased area for the purpose of fish culture.

A 10 by 20 portable house was set up near the falls at Weir River and fitted with berths, stove and cooking utensils to accommodate six men. Here the crew lived, and the arrangement proved very satisfactory, for a considerable saving resulted in the amount of time and money spent in traveling, and the men were available at all times. An open shed 7 by 8 was built as a shelter for the spawn takers. Specially made benches made it possible to handle more fish and take more spawn in

less time than last year. A 40-foot bridge was built across the stream to replace the old one which had been carried away with a high tide last winter. The new one is built so that it can be removed and stored at the end of the season.

The salt-water smelt season of 1919 was an unusual one. With an open winter the fish came to tidewater in the rivers in January and lay there until March 1, when the run was on, earlier than is usually the case.

No plants of eggs on burlap were made this year, last year's work having demonstrated that the eggs could readily be hatched into fry.

On March 6 there was a large run of fish at Weir River and Fresh River, and they were in perfect condition for spawn-taking. On March 10 the first spawn, about 35 quarts, was taken. Cold weather and low water temperature followed immediately and lasted until March 23, when eggs were again taken. Unfavorable conditions continued, and on April 14 part of the crew was sent home as the run was over, and what fish came were very few and small. Enough men were kept for patrol work. On April 22 there was a good run of fish, and on April 23, 55 quarts of smelt spawn were taken. As a result of the season's work, 100,572,000 green eggs were shipped to the Palmer Hatchery, each shipment accompanied by a messenger.

The fish to be stripped were captured this year by setting a 60-foot seine, at sundown, at an angle on the river. When the fish came in it was drawn across the stream and beached below the spawning bed. By this method one man could bring all the fish the strippers could handle, whereas by the old way two, and oftentimes four, men were hunting fish and walking over the spawn bed. The first few nights of the run, it has been noticed, are the best for taking eggs, as the fish are full, having shot none of the spawn. After ten days a great difference can be noticed in the fish. They soon begin to harden, and the quantity of spawn is less. On moonlight nights the run is not so heavy and the fish are very wild, whereas on dark nights they lie very still and have no fear of a noise. In previous years spawn has been taken at night (when the smelt run) and shipped to Palmer on the first train in the morning. Another year, by putting a net behind the fish after they have come up

at night, they can be held until the next day and work done by daylight. By experimenting it has been found that the eggs can be held forty-eight hours without injury. By so doing the spawn-taking crew can be reduced one-half.

Temperature records of water were kept as follows: —

| | Noon (Degrees F.). | Midnight (Degrees F.). |
|---|---|---|
| March 6, | 37 | 35 |
| March 7, | 38 | 36 |
| March 8, | 40 | 38 |
| March 9, | 39 | 37 |
| March 10, | 40 | 37 |
| March 11, | 38 | 36 |
| March 12, | 40 | 37 |
| March 13, | 37 | 31 |
| March 14, | 38 | 30 |
| March 15, | 30 | 29 |
| March 16, | 30 | 30 |
| March 17, | 29 | –[1] |
| March 21, | 40 | 40 |
| March 22, | 40 | 39 |
| March 23, | 37 | – |
| March 24, | 47 | 42 |
| March 25, | 43 | 42 |
| March 26, | 46 | 44 |
| March 27, | 47 | 44 |
| March 28, | 43 | 37 |
| March 29, | 30 | –[2] |
| March 30, | 31 | –[2] |
| April 4, | – | 39 |
| April 5, | 39 | 39 |
| April 6, | 38 | 38 |
| April 7, | 41 | 44 |
| April 8, | 48 | 49 |
| April 9, | 48 | 46 |
| April 10, | 42 | 44 |
| April 11, | 48 | 48 |
| April 12, | 50 | 50 |
| April 13, | 51 | 50 |

[1] Ice on ponds and rivers. [2] Ice on falls.

At Weir River there was a large deposit of spawn on the first run, which, owing to the method employed in seining the smelt, was not injured by being walked over. On account of the extremely cold water and the unusually low water for springtime, which left the spawn exposed to the sun, the percentage hatching was small, but on the last run there was a large deposit of eggs and a good hatch.

Great numbers spawned in Straight Pond, Cohasset. At Back River, East Weymouth, there were very few fish, and spawn could be found only on close examination. At Fore River, Weymouth Landing, there was a small deposit on the last part of the run. In other small brooks, where in other years smelt and spawn have been seen, none was noticed this spring. Without attempting to make a detailed survey, the reports indicate that smelt are increasing in the coastal streams which still continue to be suitable for them.

An experiment was made in stocking the Jones River, Kingston, with smelt. When the smelt spawn in the brook at Hingham had reached the eyed stage, about 2 bushels of grass and pieces of sod to which eggs were attached were collected. Parts of the river bed had previously been prepared for the reception of spawn by building, of stones, fourteen pockets, or stops, in the shape of a horseshoe, to break the current and make quiet water where the spawn could be left to hatch naturally. Some of the grass and sod was placed in boxes 4 by 14 by 20 inches, covered with netting to keep the eels from eating it, and the boxes anchored in these pockets. The experiment was carefully followed, and it is believed that nearly two-thirds of the eggs placed in the boxes hatched.

When not occupied in taking spawn the deputies patrolled the brooks against poachers. There were no prosecutions this year at the Fore and Back rivers, for there were no fish to tempt people to go after them. It would take an hour for a person to get half a bushel of smelt, whereas the year before 2 bushels could be taken with a few dips of the net in fifteen minutes' time. This scarcity does not signify a decrease in the number of smelt, but merely that they did not run into the brooks in the usual numbers, owing to the peculiarities of the season. The season was a long one, with spells of cold weather

which drove the fish back, and extended the spawning season from the usual four weeks to eleven weeks. The fish came along in small numbers instead of large runs, as would have been the case had the season been normal. Press of other work made it imperative that the men attend to other matters, and they were gradually taken from the brooks. The last went before the final run of smelt in the rivers. During this last run a few complaints were received that smelt were being taken by boys at Weymouth Landing, but the run was over before this could be followed up. On the whole, there were few violations during the season.

*Fresh-water Smelt.*

Fresh-water adult smelt were collected as usual at Parker Brook, into which the fish run from Onota Lake. The working force consisted of from two to four men, as the work required, and last year's methods in collecting and shipping were followed with a few slight modifications. The run started on the night of April 4 and continued until the 12th.

Distribution began April 8 and continued, with from one to three consignments a day, until the 24th. This was the best that could be done on account of limited train service. There was no loss of fish in the holding tanks as in former years, for with an adequate number of men distributions were completed before warm weather.

The smelt were larger than any taken the past four years, averaging 7 inches, and 49,700 were distributed from Onota Lake to other waters. Twenty-six shipments of eyed spawn (about 26,000,000 eggs) were planted beginning May 10.

The work of taking smelt at Onota Lake has a twofold purpose: first, to supply brood stock for ponds in which it is desired to introduce or increase smelt as a food supply for other fishes; and secondly, to reduce or keep down the smelt in Onota Lake.

The taking of smelt has always been regulated by law, but it is evident that salt-water smelt only were in the minds of the legislators. There is no reason why certain numbers of the fresh-water smelt should not be used for bait for fishing in inland waters. In order to make this supply available the Legislature, during the past session, upon the recommendation of our

Board, provided that the Board may make rules and regulations, subject to the approval of the Governor and Council, permitting such use.

### Horned Pout.

The horned pout is increasing in popularity, as judged by the number of applications which have been received for this fish. During the past year we have distributed 63,100, seined from waters which had a good supply. There were 800 stranded horned pouts salvaged from the setbacks in the Connecticut River by the district deputy and put into the Oxbow.

### Winter Fishing.

Winter fishing has always been a popular form of sport and is steadily growing in favor.

Throughout the whole Connecticut River region we had uniform reports of larger catches during the winter of 1918–19, — larger than for years past. The winter before that (1917–18) was an exceptionally severe one, with bitter cold days and thick ice. This was unfavorable for fishing, and practically amounted to a closed season for the fish. The winter just past, with mild weather and no undue amount of ice, brought out large numbers of fishermen.

Through the Housatonic River region about average catches were made. In the northeastern and southeastern parts of the State, near the coast, so little ice formed that there was almost no opportunity for ice fishing.

### Ponds Stocked and Closed.

The regulations on Hardwick Pond, Hardwick, applied at the time the pond was stocked and closed in 1918, were changed in 1919. Under the new regulations fishing is permitted in the pond from June 1 to October 31, and in its tributary streams from April 15 to the following July 31, inclusive, with a hand line or with a line attached to a rod or pole held in the hand.

During 1919 the following ponds were stocked and closed to winter fishing, pursuant to chapter 285, Acts of 1911: Quabbin Lake, Greenwich, and Long Pond, Littleton.

Each of these ponds has been closed to winter fishing from

Nov. 1, 1919, to Nov. 1, 1922. Fishing is permitted in the pond from June 1 to October 31, and in its tributary streams from April 15 to the following July 31, inclusive, with hand line or with a line attached to a rod or pole held in the hand.

### Great Ponds Leased.

Under chapter 39 of the Acts of 1919 Tisbury Great Pond, in Dukes County, was leased to the riparian owners, for the purposes of fish culture, for an additional period of five years. The lease was dated Nov. 12, 1919, and takes effect Jan. 1, 1920.

### Screens.

We are more than ever convinced that unless the great ponds which have outlets are suitably screened, much of our effort to stock them will be futile. This is work which we recommend be done by the Commonwealth and paid for as a State enterprise, for the reason that we are dealing with waters which for all time shall be open to the public for free boating, fowling and fishing. In fact, the great ponds of the Commonwealth are the only inland waters where we are certain that public interests will be preserved, and for this reason they should be put into a physical condition that will insure favorable results from stocking. At the present time the expense is borne by individuals or clubs who may have a particular interest in a given pond. In our budget for the coming year we have asked for an appropriation of $1,000 with which to continue this work.

Mr. Don V. Messer has had a screen constructed and installed at Norwich Lake, Huntington. It is made of steel bars set one-fourth inch apart, is 5 by 6 feet in size, and is apparently ample to take care of the flow of water from the lake. This is a fine body of water, capable of producing an abundance of food fish if stocked with smelt, which the Commissioners plan to do to develop the fishing in it.

A screen was put in at the outlet of Spectacle Pond, Lancaster, by the Leominster Sportsmen's Association. It is of galvanized wire, one-half inch mesh, 8 feet long and 4 feet deep. It was set in place soon after the plants of salmon were made.

## Fishways.

The installation of fishways has progressed steadily during the past year. Our efforts have been directed almost entirely to the alewife streams, as these presented the greatest need for immediate action in order to insure the preservation of the alewife fishery.

Two conditions present difficult problems, — (1) impassable dams and (2) pollution.

The decline of this valuable fishery has been due largely to obstructions in the form of dams which prevented the fish from reaching their spawning grounds. Dams are the inevitable result of the inroads of colonization following the waterways. The mere presence of dams is not dangerous. Only when they are unequipped with fishways, or are not opened during the spring run, do they become a menace. The installation of proper fishways around these obstructions is therefore the first consideration.

The requirements for a successful fishway are: (1) easy and rapid passage for all species of fish, with uniform flow of water, gradual ascent and absence of high barriers; (2) a minimum sacrifice of water in the interest of dam owners; (3) an entrance into which the fish are readily directed; (4) a firm, solid construction, resistant to freshets, or one which may readily be removed when not in use. The chief point to remember when installing a fishway is that it is not only the type of fishway, but *how it is located,* which determines its success or failure. Each dam presents its individual problem. In installing a fishway the following conditions must be considered: —

(1) *Water Flow.* — Almost any device may be used which will insure a sufficient and steady volume of water (but no more) to operate the fishway.

(2) *Entrance.* — Instinctively the fish follow the current as they come up the stream to the obstruction. Therefore the entrance must be located so that the fish will easily find it and enter it from the main current of the stream. Sometimes in order to prevent the fish from "pocketing" at the base of the dam, where by reason of the large volume of water coming over it they may be slow in detecting the small current coming from

the fishway, the entrance to the way is located down stream at some distance, and the fish are directed to it by a temporary screen or barrier put across while the fish are running.

(3) *Materials.* — Our Board has never insisted on any special quality of materials. Most concerns prefer to build of steel reinforced concrete as being the most economical in the long run.

*Standard Fishways.*

A fishway which will take all species of anadromous fish successfully has never been invented. In our work two types have been designed and have proved satisfactory, meeting all the requirements for the alewife streams. No claim is made, however, that these are the long-sought universal fishway, or that they are suited for other species of fish.

*David Fishway.* — This fishway may be either of concrete or wood construction. With its sloping bottom and irregular baffles it resembles the Brackett type, but possesses the additional qualifications of frequent rest pockets and a steady, uniform flow of water, which is controlled by the upper gate. Although more expensive than the second standard type, it can be advantageously installed in a limited space over an irregular course.

*Straight-run Fishway.* — This fishway is especially adapted for low dams where the contour of the river bank below the dam affords a footing on a gradual slope. This primitive form of fishway resembles rapids in a natural stream, with water spilling from each pool into the one below.

Section 9, chapter 91, Revised Laws, as amended by chapter 365, Acts of 1904, and sections 10 and 11 of chapter 91, Revised Laws, require that dam owners shall, on the order of the Fish and Game Commission (which furnishes plans and specifications for every fishway), install suitable fishways at their own expense, and keep them open at specified times, under penalty of a fine of $50 per day for non-compliance. Some owners of dams have immediately responded to our efforts to open up the streams; others have almost forced us into taking legal measures to insure the work being done. Installations are steadily progressing, and it is hoped that soon all the potentially productive streams will be completely equipped.

Dam at the Stanley Works, Bridgewater, May 13, 1919. Impassable to fish. Engineer laying out proposed fishway.

Completed fishway (straight-run type) at dam of Stanley Works, Bridgewater.

*Taunton River Fishways.*

The first fishway to be installed under the standard plans designed by the late Allen A. David and R. Loring Hayward, consulting engineer to the Commission, was built in 1918, at East Taunton. This was of the David type. The building of this way comprised the first step in opening the Taunton River for the restoration of the alewife fishery. Results during the spring run in 1919, as reported by Mr. Merrill Dean, the watchman for the towns interested in the fishery, were even better than expected. The fish passed up the new fishway in a small fraction of the time taken in the old Brackett fishway which formerly occupied the same site, and all the alewives coming up the river were easily and readily accommodated.

By the proper installation of fishways upon the upper branches of the Taunton River alewives will be given a chance to spawn in the Assowompsett, Monponsett, Robbins and Nippenicket ponds. During the year fishways at the dams of the G. O. Jenkins Company and the Stanley Works, situated on the Taunton River and the Town River, respectively, in the town of Bridgewater, were satisfactorily completed, and are all prepared for use during the coming spring.

The first of these to be finished, that located at the Stanley Works, on the north side of the Town River, is of the straight-run type, built of re-enforced concrete, and comprises a concrete flume, a portion of the south wall of which extends downward to form a retaining wall for the north bank of the river. The floor of the flume has a gradual slope from the intake at the top of the dam to the level of the river bottom below. Cross walls, called steps, are placed at regular intervals along its bottom in such a manner as to divide the flume into a set of pools, with water spilling from one pocket to another when in operation.

The other, located on the property of the G. O. Jenkins Company, is somewhat similar in design to the description set forth above, except that it is not nearly as long, and is equipped with removable timber baffle boards instead of the cross walls of concrete present in the Stanley Works structure. As originally planned, this way was to have been one of the David

type, but unfortunately certain reverses were met with at this location which resulted in a serious setback to the early completion of the work. Early in the month of September, following heavy rains, the water rose one night at the dam of the company to the extent of 5 feet 4 inches in a period of four hours, flowed over the top of what new construction had been placed, and washed away the earth where it had not been banked up against the back of the fishway walls, with the result that the structure was so undermined as to cause its collapse. Thereafter, at the request of the contractor and the company, modifications in the plans to the extent of permitting the installation of a straight-run fishway were assented to. The undaunted manner in which operations on the project were immediately recommenced after this catastrophe is worthy of commendation.

Much credit should be given these concerns as being among the first to do their part in opening up the river.

*Lawrence Fishway.*

Renewal of the legislative appropriation for the construction of a fishway at the dam of the Essex Company in Lawrence having been secured for this year, work on this project was prosecuted with as much expedition as the adverse circumstances of the case would permit.

The type of fishway finally evolved as best satisfying the requirements of this particular location on the Merrimack comprises a series of tanks or pools leading from the level of the river bottom below the dam to that of the pond above. Each pool, when in operation, will have a depth of 3 feet and a floor space of 64 square feet. Openings 4 feet wide lead from one pool to that next above and below, and the grades are so regulated that at each one of these openings a little waterfall will be formed. For the sake of economy, and to secure a maximum grade in a minimum total length, the boxes or pools are arranged in a double row, the waterway zigzagging first to the right and then to the left. Owing to the great violence of the river at the southern end of the dam, the particular locus of the way, especially during the season of ice jams in the spring, it was deemed necessary to construct the whole way of re-

enforced concrete. To give it as solid a foundation as possible, and also to avoid reducing the cross section of the river at flood stages, a portion of the ledge present on the site was blasted away, and the shelf thus made was used to support the fishway. Where the ledge was lower than the desired level of the fishway, the latter was built up of rubble concrete, to the end that economical use might be made of the materials at hand. The result is that the irregular rock river way is replaced with a stronger mass of homogenous material with smooth exterior, offering less obstruction to the river.

A space was left between the feed flume of the way and the crest of the dam in order that there might be no obstruction to the free flow of water over the dam, and to the end that this upper portion of the way might be saved from the destructive influence of ice and other débris in the spring season. This space is to be spanned by a steel flume open at both ends. This flume is operated by means of an overhead track, and may be placed on the crest of the dam at such times as are deemed necessary for the passage of fish. Whenever considered essential to its safety, this steel flume may be easily withdrawn into the feed flume of the fishway proper.

Rising cost of materials and labor made the original appropriation inadequate. This year the Legislature made an additional appropriation which, in addition to the balance of the first appropriation and the sum of $2,500 to be contributed by the Essex Company, made the sum available sufficiently large to accept the lowest bid submitted for the work, that of the firm of George T. Seabury, Inc., of Providence, R. I., — $23,455.90.

The novelty of the problem, the lack of successful examples from which to obtain ideas, and the care necessary to avoid the mistakes of other designers made preliminary progress much slower than in the case of other structures by this time more or less standardized.

After numerous preliminary negotiations incidental to the work, including the obtaining of required permits from the Commission on Waterways and Public Lands of Massachusetts and from the United States War Department, physical work on the proposition was commenced on Aug. 25, 1919. The con-

tract was dated Aug. 12, 1919, and provided that the contractor should commence the work within thirteen days after that date, the whole work to be performed in accordance with the terms of the contract in or before ten weeks. At that time this seemed perfectly feasible. But all manner of unforeseen, extraordinary natural conditions made this impossible. Two economic factors in the delay were labor troubles and difficulty in obtaining the structural steel necessary owing to the strike in the steel industry. In addition to this, the continual rise of the river became so great in volume as on November 1 to seriously bend and loosen the flashboards of the dam, particularly near the scene of operations, and demolished a considerable portion of the false work, thus nullifying some of the work accomplished. From this date on the continuing high water submerged a considerable part of the site all of the time, the water flowing over the dam having attained a maximum depth of 6 feet over the masonry of the dam during this period. Moreover, this displacing of the flashboards, in addition to spilling immense volumes of water over the bent boards, allowed even greater quantities to leak through along the crest of the dam. As this lower stream came in contact with the main stream flowing over, a heavy spray was produced. This spray, carried by a prevailing strong wind, enveloped the work in a continual shower of moisture, with the result that it was almost impossible to keep men at work. On November 20 a fall in temperature caused this dense mist to freeze as soon as it struck the fishway and adjacent land, resulting in the formation of a heavy coating of ice over the whole lower portion of the structure, the part at that time under construction, and making the prosecution of further work impracticable.

At the end of November three-fifths of the total length of the fishway, including the highest and most difficult portions, was quite complete, with the exception of three of the pillars for the support of the movable flume and a portion of the third section of pools. Mr. George T. Seabury, the contractor, at that time was continuing with the work with as many men as the offer of a generous bonus could induce to face the severe physical conditions under which work had to be done. He was of the opinion that at least this much could be finished this year, and

continued operations in spite of the severe weather conditions, in the hope that the work might be progressed to a point which would make it usable next spring. With the upper three-fifths of the fishway completed, it was felt that a temporary wooden structure leading down to the river bed would be sufficient in all respects to serve the requirements of any fish which might seek to ascend the dam this coming season. It is doubtful, however, if with the money in hand this temporary expedient will be possible.

In accordance with the requirements of chapter 174, General Acts of 1918, and subsequent appropriation acts, which stipulate that all receipts and expenditures shall be set forth in the annual report of the Commission, we herewith make the following report: —

*Appropriations.*

| | | |
|---|---|---|
| Balance of chapter 161, Special Acts of 1918, brought forward from 1918, | $8,934 17 | |
| Chapter 211, Special Acts of 1919, | 5,000 00 | |
| Chapter 242, Special Acts of 1919, | 11,000 00 | |
| | | $24,934 17 |

*Expenditures.*

| | | |
|---|---|---|
| Expenses of engineer, including travel, services, tracings, blue prints, models, etc., | $1,189 55 | |
| Travel of employees, | 3 98 | |
| Blue prints, | 32 28 | |
| Advertising (proposals), | 161 44 | |
| Contract for construction of fishway, | 23,455 90 [1] | |
| | | 24,843 15 |
| | | $91 02 |

*Lowell Fishway.*

At the time plans were adopted for the installation of the Lawrence fishway the location at the dam of the Locks and Canals Company at Pawtucket Falls, Lowell, was also studied. While the physical proportions of the work are not so great, nevertheless there is a substantial problem at this dam if a fishway is to be designed which will accommodate the alewife as well as the salmon.

[1] Of this amount only $8,415 had been disbursed previous to Nov. 30, 1919.

A model has been constructed of a proposed fishway around the above obstruction, and through our engineer we are now working on the problem in conjunction with the officials of the Locks and Canals Company.

## Water Pollution.

The most serious problem confronting our fisheries is water pollution. If allowed to increase it means the serious depletion or even the ruin of a large part of our fresh-water fisheries, and the longer it remains unregulated the more difficult will become the solution. Indeed, it is to be questioned whether many grossly polluted streams can ever be completely restored. Massachusetts is both a fishing and a manufacturing State. The pollution evil which vitally affects the future of her valuable fisheries is intimately connected with her manufacturing interests, a situation which renders especially difficult the application of remedial measures.

### *Forms of Water Pollution.*

Although water pollution is a public nuisance and a menace to public health, we are concerned only with the destruction of fish life by sewage and trade wastes. Owing to its prominence as a public health factor, methods of disposal have been devised for eventually controlling sewage pollution entering the streams from private toilets and cesspools and in the form of effluents from municipal systems, thereby causing damage to water supplies and manufacturing interests, contaminating shellfish beds and injuring fish life. Trade wastes, which include all forms of waste material from industrial sources, present a far more difficult problem, and fish conservation will deal chiefly with this type of pollution, which not only renders the water unfit for bathing and drinking, but directly and indirectly destroys fish life.

Considerable experimental work must be done before we shall be in a position to judge how great an amount of pollution a fish can survive over a long period. In flagrant cases the effect of severe, new or transitory pollution is readily indicated by the presence of dead or dying fish, yet slow, continuous pollution may be fully as harmful when its cumulative effect over a long

period is considered. The cases which show an appreciable effect upon the fish life in the streams should be remedied as soon as possible, since they are causing the greatest damage. In instances consideration must be given the value of the stream for fishing, the nature of the polluting substance, and the cost of its elimination.

The direct effect of pollution is to injure the fish so as to cause their death or render them susceptible to disease; reduce the natural supply of free oxygen in the water; render the flesh unfit for food; or to drive the fish away. The indirect effect may be even more disastrous through the destruction of the eggs and young, the restriction of spawning and feeding grounds through changes in the bottom vegetation, and the destruction of the food supply.

In Massachusetts all classes except the deep-sea fisheries are affected by water pollution. Sewage is a source of danger to the public health not only through contaminating shellfish, but also closing large productive shellfish areas, and causing the wholesale destruction of the spawn. Trade wastes destroy shellfish, particularly the larval forms, render them unfit for food, and diminish the spawning grounds, while the presence of concentrated quantities of sewage or trade wastes drives migratory fish from our coasts. The coastal streams by sewage and chemicals are rendered unfit for the passage of anadromous fish on their way to their spawning grounds, thus directly injuring the alewife fisheries and indirectly affecting the shore fisheries. The greatest pollution is to be found in the inland waters, where nearly every stream of importance receives a variable amount of sewage and trade wastes.

### *Work during 1919.*

During 1919 three cases of pollution were investigated, and the opinion of the Commissioners was requested in another under chapter 460, Acts of 1910.

1. *Athol Machine Company.* — The opinion of the Commissioners was requested in regard to the disposal of sand from the company's sand blast in Millers River. After reviewing the facts in the case it was decided that no harm to fish life could result from this material entering the stream.

2. *Brewer's Sawmill.* — Reports were received that the Konkapot River, a splendid trout stream, was being damaged by shaving wastes from the sawmill of C. B. Brewer at Mill River. Upon investigation the amount of polluting substances entering the stream proved so small, and the damage so questionable, that further action was deemed inexpedient.

3. *Thomas A. Kelley & Co.* — Little River, a tributary of the Saugus, was reported on April 25, 1919, as polluted with acid from the plant of the Thomas A. Kelley Company factory at Lynn. Investigation showed that the damage was caused by the plugging of the sewer, and the company was proved quite innocent in the matter. The trouble was speedily remedied by the prompt action and ready co-operation of Hon. Walter H. Creamer, mayor of Lynn, and the Lynn board of ways and sewage.

4. *Russ Gelatine Company.* — Pollution of Sandy Mill Brook, Westfield, by caustic soda and muriatic acid, was reported on July 7, 1919. The matter was brought to the attention of the company by letter on July 17. In a personal interview on July 22 the president of the company stated that he would look into the matter of establishing filter beds. On August 18 and September 29 the death of fish was observed to have continued, and the company's attention was again called to the fact by letter on September 17 and October 3. At that time the company promised to take the matter up with Commissioner Graham at Springfield. On November 17 a diagram of the proposed settling pit was submitted by letter to the Board, and the ready co-operation of the company assured.

## PROPAGATION OF FISH AND GAME.

### Report of the Sandwich Fish Hatcheries.

On Dec. 1, 1918, William M. Monroe, formerly foreman of the Palmer Fish Hatchery, was appointed superintendent of the Sandwich Fish Hatcheries in place of Frank E. Hitchings, deceased.

Along with the regular work but few alterations were made at the hatcheries during the past year. A small hatch house was set up to give the space necessary for eyeing out all the eggs before shipment. It will hold a similar number of trout fry for a time. A portable garage was set up at Sandwich for housing the truck, and a new Stewart truck added to the equipment. Wherever possible springs or streams were utilized in the construction of rearing pools; wells were driven; and eight wooden pools from the Adams Hatchery (now discontinued) were set up at the Sandwich Hatchery on the north side of the meat house. The clearing of grounds and some minor changes completed the improvements for the year.

### *Brook Trout.*

When the present superintendent took charge of the Sandwich stations on Dec. 1, 1918, the spawning season had closed and three or four consignments of eggs had been distributed. The brood stock on hand consisted of 21,000 yearlings and 16,578 adults.

A total of 4,248,552 eggs had been taken, part of which were disposed of as follows: —

| | |
|---|---|
| Sutton Hatchery, green eggs, | 783,552 |
| Mr. L. B. Handy of Wareham, for experiment in new method of planting, eyed eggs, | 100,000 |
| Sutton Hatchery, eyed eggs, | 515,000 |
| Montague rearing station, eyed eggs, | 800,000 |
| Canada (in exchange for Atlantic salmon eggs), eyed eggs, | 200,000 |
| California Fish Commission (in exchange for salmon eggs), eyed eggs, | 250,000 |
| Wisconsin Fish Commission (in exchange for rainbow trout eggs), eyed eggs, | 200,000 |
| | 2,848,552 |

The remaining 1,400,000 eggs were retained for hatching, which was completed January 22, resulting in 1,200,000 fry. Some were distributed as fry, and part reared to fingerlings. These were disposed of as follows: —

| | |
|---|---|
| To Southeastern Fish and Game Association of Brockton for rearing to fingerlings before liberation, fry, | 40,000 |
| Amherst rearing station, No. 2 fingerlings, | 352,575 |
| Distributed to public waters, No. 3 fingerlings, | 219,750 |
| | 612,325 |

Nearly all the losses of fry occurred in the lower cement pools at the Sandwich Hatchery, by reason of insufficient water supply through these ponds.

There were 2,930 adult fish distributed during the year.

The 19,444 wild brook trout received from the Palmer Hatchery were retained as brood stock.

In the fall 5,000,000 eggs were taken for the coming year's work.

*Rainbow Trout.*

On March 22, 171,000 rainbow trout eggs were received from Madison, Wis., in exchange for 200,000 brook trout eggs. When unpacked they were found to be in very poor condition, large numbers having formed into masses covered with fungus, and the losses were large. They started hatching March 27, and were carried at the station until fall, when 30,425 fingerlings were distributed to public waters.

*Chinook Salmon.*

Between September 8 and 17, 14,100 Chinook salmon fingerlings were received by auto truck from the Palmer Hatchery for rearing, and in the course of the fall were planted in ponds.

We had an opportunity this year to experiment with the propagation of landlocked Chinook salmon, and to test the commonly held theory that salmon die after spawning. At the

East Sandwich Hatchery 12 mature salmon hatched in 1915 had been kept for show and experimental purposes. On October 2, when 8 appeared ready to spawn, the fish were caught and 3 females at this time and 5 small males were found to be ripe. Three large males were not ripe. Eleven ounces (1,650 eggs) were taken on October 2, and on October 6, 6 ounces (900 eggs) more. The 2,550 eggs placed on trays at the Sandwich Hatchery hatched well, and at the time of making this report had developed into strong, healthy fish. When the Chinook salmon are ready to spawn they turn dark yellow. The eggs are much lighter in color than those taken from the fish in salt water. After the adults were stripped they were put back into the pond, and in a few days both male and female began to show signs of fungus, and died ten days after stripping. The fungus began on the tail and back fin and finally covered the whole fish, the fins rotting away. The fish grew thin rapidly, the flesh wasting away so that at the time of death they were mere shadows of their good condition ten days previous at the time of spawning. As an experiment one female was left in the pond to spawn naturally. This fish, too, eventually died. Some time ago a number of Chinook salmon which were held in the pond at the Palmer Hatchery were found dead and covered with fungus in the spring, after the ice had gone out. Probably these fish had spawned and died in the same manner.

This is the first time, to our knowledge, that the eggs of the Chinook salmon have been taken in fresh water and successfully hatched in Massachusetts, and possibly, with one or two exceptions, in the world.

The young Chinooks were retained at the hatchery. It is our intention to rear them to mature fish and breed from them, with a view to ascertaining whether Chinook salmon hatched and reared in fresh water die after spawning, as is the case with the salt-water species.

### *Atlantic Salmon.*

The 220,000 Atlantic salmon eggs received from the St. Johnsbury Hatchery in Canada came through in excellent condition. They were placed on trays at East Sandwich and finished hatching March 17, but a great many of them, being weak, died in the sac stage. A rather large loss was experienced at the hatching period, many breaking open and dying just before they hatched. This may have been due to imperfect development of the fish in the eggs. It was noticed that most of these eggs were a little lighter in color than a healthy one, and by holding the egg to the light it could be plainly seen that the fish was immature. Some of such fish survive the hatching period, but generally result in blue sacs or cripples of some kind. Some die in the eggs and break open. Atlantic salmon are more susceptible to injury through handling than any other fish. This was the first year Atlantic salmon have been handled at the Sandwich Hatcheries. The only place they seemed to thrive was in the new wooden pools at the Sandwich station. There were 3,000 distributed.

### *Alewives.*

Some experimental work in the artificial hatching of alewives was carried on, an account of which will be found in the section of this report on "Alewives."

## Report of the Palmer Fish Hatchery.

The work has been conducted on about the same scale as in former years, but owing to the shortage of labor the propagation of certain species fell below normal. The plan is to carry a moderate-sized permanent force, and to employ temporary help during the busiest part of the season. The inability to obtain such help was a great handicap, and reflected in the output of the year.

Very little was done in the way of improvements to the station. An 8 by 10 foot building was built near the rearing pools for housing the refrigerator and storing the material used

in caring for fish. A rearing pool was started between the highway and bass pond No. 1, of temporary construction, and finished so that it could be used this season in rearing salmon. This made it possible to rear to fingerlings 40,000 salmon for which otherwise there would have been no accommodations. Work was begun in grading and filling in back of the superintendent's house.

### *Chinook Salmon.*

There were 450,000 Chinook salmon eggs received from the Pacific coast. They arrived in good condition, were hatched in the usual way, and retained until they had reached fingerling size. They were distributed thus: 14,100 were sent to the Sandwich Hatcheries for further rearing; 278,500 were planted in tributaries of the Merrimack River as 2 to 6 inch fish; and the remaining 60,760 were planted in ponds.

### *Brook Trout.*

Sixty thousand eggs collected from wild brook trout in one of the hatchery brooks and supply ponds were hatched with very small loss. All were put into one large pool and held until time of shipment. At this time about two-thirds were feeding, and the remainder still had the food sac. On July 14 (at which time the fish were $2\frac{1}{2}$ to 5 inches in length) shipments were commenced to the Sandwich Hatchery, to which 19,444 fingerlings were shipped to be reared for brood stock. The remaining fish were held in one large pool, an experiment to determine what per cent could be raised in this manner. The experiment was not a fair one, however, as the fish were of different ages when put into the pool, owing to the unevenness in hatching. However, the results show that without doubt if the fish had been all of the same age when planted, this scheme of raising them would prove a much better success than to rear them in numerous small pools. There were 9,800 fingerlings distributed to the public waters.

### *Yellow Perch.*

The eggs of this species were procured, as in the past two years, from the Ludlow Reservoir; 20,000,000 were taken and hatched by the battery system, and 14,900,000 were planted in public waters as fry and 500 as fingerlings.

### *Pike Perch.*

The supply of pike perch eggs for this year's hatching was collected in Vermont by our own men. (For detailed account, see the section on "Pike Perch" in another part of this report.) From the 14,625,000 green eggs collected and shipped to the Palmer Hatchery, about 47 per cent, or 7,000,000 fry, were hatched and planted, — a very good hatch from green eggs, as there is always a large loss in the hatching of pike perch. There were 1,240,000 additional fry hatched from eyed eggs received from the United States Bureau of Fisheries, and distributed.

### *Lochleven Trout.*

On January 8, 10,000 Lochleven trout eggs were received from the California fish and game commission. They arrived in good condition, and about 9,000 fry were hatched following the methods of hatching brook trout and salmon eggs. Soon after hatching, however, the young fish commenced to die from some unknown cause, and the losses continued until they had made growth to about 2 inches. It was noticed that they were very slow in taking food, especially in the fry stage. There were 1,000 good-sized fingerlings reared and liberated.

### *Small-mouth Black Bass.*

The bass culture work at the station this year was not as successful as we had hoped, owing to the loss of some of the brood stock early in the spring, and to the inability to obtain the necessary labor at the time when it was most required. We had no facilities for obtaining additions to the brood stock, and there was unavoidable delay in putting the ponds into condition and in getting the beds set for the brood stock. During the fall about 50 adult small-mouth black bass were obtained,

and these, together with the stock which we expect to get next spring, should be sufficient to supply all of the brood fish which will be required. There were 3,400 fingerlings distributed.

### *Salt-water Smelt.*

There were 100,572,000 eggs of the salt-water smelt received for hatching from the field station at Weir River, Hingham, more detailed account of which appears in the section of this report on "Smelt." There were 83,000,000 fry distributed in the coastal streams.

## Report of the Sutton Fish Hatchery.

The Sutton Hatchery throughout 1919 was operated merely as a rearing station (no brood stock being carried), and as such it has been distinctly successful, though not yet developed to the extent of its possibilities. The work of improvement was carried on to only a limited extent, and was confined wholly to replacements, the removal of abandoned equipment, and such changes on the grounds as would simplify the care and improve the general appearance.

Late in 1918 the reconstruction of the dam was undertaken to improve facilities for handling fry, and to provide a permanent structure, in consideration of the value of the pond in producing fry. The original dam was built over sixty years before, and was rebuilt in 1891 when the hatchery was located here. It was again rebuilt in 1905, and has stood from that time with no further repairs.

The embankment carrying the road past the pond was not disturbed, but the old wasteway and underdrain was dug out, replaced with concrete and tile, and a concrete wall built in place of the plank facing. Screen frames and flashboards were provided for both above and below the road to facilitate handling the fish, and a conduit was provided for use in running the fish into a sorting pool below, to be constructed later. The dam was completed late in December, 1918, and the pond filled for cutting ice. The road was graded to a higher level in crossing the dam, and also on the west side, where it was widened to give a better approach. The shores of the pond

approaching the dam were graded and walled with field stone to conform to the other finished shores, and a pipe railing built across the dam, to follow the shore a short distance by later construction.

The water supply for the house was further improved by drawing the supply from the hatchery pipe and pumping it with a pump operated by the motor that runs the meat chopper. The motor brought from Andover rearing station being found to have power sufficient for other machinery was belted to an 18-foot line of shafting, and placed so that it would run any other small machinery found useful.

*Trout.*

Near the close of 1918, when the fingerlings had been distributed, the station was stripped of all stock, and the last of the year was spent in making improvements to facilitate work for the next season.

On Nov. 21, 1918, the first of the eggs were received from the Sandwich Hatchery. There were 783,552 eggs shipped immediately after stripping, as green eggs, in distinction from the partly matured, or eyed eggs, received later. Between Dec. 18, 1918, and Jan. 3, 1919, three shipments of the eyed eggs were received, amounting to 515,000, making the total of eyed and green eggs received 1,298,552. The first two shipments of eyed eggs were normal in size and condition, but the last contained many late yearling eggs in mixture with the larger ones. Consequently many of the fry, from later hatching and feebleness, were unfit for rearing, and increased the proportion of losses in the beginning of the rearing season. A condition like this could be well met by a distribution of fry sufficiently large to eliminate all the undersized and weak ones, as such could be easily separated from the stronger. This would not mean that the fry discarded would be in any way a waste product or added loss, for the fish that in the crowded rearing pools would weaken to the point of loss would, if scattered in suitable nursery brooks, result in a fair percentage of survivors.

The green eggs came through in fair condition, with a loss from the transfer but little heavier than normal, and they continued with no apparent change for about ten days, when the

germinal disc was becoming plainly defined. But this, instead of undergoing the usual changes, developed a white spot indicating the death of the germ, and in a varying time involved the whole egg. The loss resulting continued at an increasing rate until early in January, when the number of eyed eggs represented less than 10 per cent of the shipment. Through most of this period it was possible to distinguish the loss of the dead fertile from the ordinary loss of infertile, which came late in the season but was no heavier than usual. This trouble has occurred in three out of the six years that eggs have been transferred from Sandwich, and has been identical each year, always among the green eggs and following the same development very closely. But so many shipments have come through in good condition during the same period that the difficulty cannot be wholly due to the transfer of the eggs green, but rather to doing the work at the wrong time, or with eggs so deficient in vitality that they could not be handled in that way. The loss in this lot of eggs was nearly 700,000, and the loss in the hatching of the eyed eggs increased the total losses to 765,000. The fry that resulted from the hatching of the remainder numbered 569,000. All were reserved for rearing, and all ponds suitable for holding them were well stocked. The proportion of unsatisfactory fry from the last shipment of eggs previously mentioned brought some of the ponds down below capacity, but the most of them carried a full quota of fingerlings.

The large pond was stocked with a smaller number than the year before (when it was used to take the large numbers weakened by overcrowding), and this smaller number gave increased results (from about 23,000 last year to nearly 30,000 this year), with no decrease in the usual large size of the fish produced the first year. This year it approximated 600 over 6 inches, 6,000, 5 inches, about 20,000, 3 to 5 inches, and several thousand smaller.

The year before some fish were kept in an experimental way in the brook channel that carries the waste water from the brook above the fry ponds to the main pond. The results were so satisfactory that for this year's work the channel was deepened and obstructions placed at intervals, so that the water flowed down through a succession of pools, falling from 6 to 9

inches from one pool to the next below. A large part of the fish intended for the main pond were placed in these pools, and, as no screens were used, it was expected that enough would work down to the pond after a brief period of feeding in the brook. However, they retained their stations so well that it was necessary to put a stock directly in the pond and let the first lot remain in the brook pools. Through the summer there was relatively little change in the numbers of fish in the pools, except where shade was lacking, and from such shadeless pools they dropped down to the shaded ones or to the pond. This channel, formerly unused because the drift and flood water made it impossible to maintain screens and keep the fingerlings separated from the adults below, yielded a stock of nearly 20,000, smaller in size than the pond fish, to be sure, but very hardy and active.

The distribution covered a greater extent of territory than the year before, and it was necessary to distribute a larger proportion by rail. A motor truck was used, however, to load the fish at the Worcester station, and all near assignments, including nearly all that went into Worcester County, were taken out by truck. Several extended trips were taken with large truck loads in cases where a cross-country trip could take in one day what would require two or three days by rail. Motor truck delivery was as satisfactory as the year before, and should be followed to an increasing extent when the assignments of fish can be made within a practical distance. The distributions of fingerlings totaled 209,600.

## Report of the Amherst Rearing Station.

The station was opened March 25 and was in charge of Arthur S. Tinkham. Between that date and April 21 shipments of 2-inch fingerlings were received from the Sandwich Hatcheries to the number of 352,575. These fish had been feeding from four to six weeks, and arrived at the rearing station in excellent condition.

Early in June Deputies Ruberg and McCarthy installed 6 new tandem pools about 25 feet north of the pools originally built. They are buried so that the top is flush with the ground, and

they are fed by a small surface stream. This was the only improvement on the grounds during the year.

On June 30 and July 1 there were heavy losses among the fish, due to the neglect of the man in charge of the station in properly caring for them. The situation developed so rapidly that the damage was done before it could be remedied.

The number of fish reared and distributed, commencing July 16, was 12,400.

On April 18, 1,500 smelt were received in good condition from the field station at Pittsfield, and were placed in some of the pools for experimental purposes. They did not feed, and died.

## Report of the Montague Rearing Station.

In 1918 the Montague rearing station was conducted as a rearing station for fry, but no hatching was done. The conditions at the station as revealed by the first year's trial seemed so promising for the hatching of eggs that an experimental hatch house was constructed at the close of the year, and equipped, ready for trial this year.

The rearing capacity of the station was increased by setting up 8 additional pools from the dismantled station at Andover, giving a total of 38 rearing pools. A shanty at the Andover station furnished lumber for the construction of an ice house, and the appearance of the station was improved by clearing away brush along the pools and in the swamp.

Shipments of eyed eggs for hatching were received from the Sandwich Hatcheries between Nov. 30 and Dec. 28, 1918, totaling 800,000.

The eggs were accompanied by a messenger in every case, and were found to be in good condition when unpacked, except that the second lot contained an unusual number of bad eggs.

On December 25 a part of the first lot had hatched, but the hatching period of the other lots averaged thirty days. On February 1, when some of the fry had commenced to feed, one trough, or 60,000, were transferred into three rearing pools.

The fry grew so rapidly that on February 4 all of the first two lots of fish were transferred into 18 rearing pools, 20,000 to a tank, where they did so well that the remaining fry were also brought down in the pools as soon as they were feeding.

On February 24 there were large losses in the first lot of fish, which had been feeding for three weeks. Next day matters were worse, and on the 26th Superintendent William M. Munroe of the Sandwich Hatcheries visited the station to ascertain, if possible, the trouble. Clay and salt baths were administered and certain changes made in feeding methods, but the trouble continued, and by the time the second lot had been feeding three weeks the same trouble manifested itself. The fish appeared to be in a healthy condition, with no fungus, and upon examination no trace of anything unusual could be noticed to indicate the cause of the losses. Losses continued until the last lot of fish was about three months old, and then decreased to only a few a day. The fish were fed on fresh liver five times a day at the beginning, and four times the remainder of the time. Growth was slow during the spring months, but from the middle of May to the distribution season they kept up a steady growth.

Distribution was started June 25, and made by auto truck direct to the streams. Total number of fish planted in the public waters was 36,000 fingerlings from 2 to 3½ inches in length. Distribution was completed July 10, and the station put in shape to be left for the winter.

The 70 acres of land on which the rearing station is located, which was leased until the suitableness of the water had been fully tested, was purchased on Nov. 28, 1919; 40 acres from John Bitzer for $1,100; and 30 acres from Joseph T. Fournier for $750.

## Pittsfield Rearing Station.

Our experience with this station during the one year that it was operated convinced us that the water was unsuitable for trout culture, and it was not deemed advisable to conduct operations there this year.

## Report of the Marshfield Bird Farm.

Very little construction work was done at the Marshfield Bird Farm during the year, owing both to lack of finances and lack of labor, for help was difficult to obtain, and only one assistant was kept during the winter.

Arrangements were made to transfer the incubators from the

cellar of the superintendent's house to the basement of a newly constructed building, where it was possible to have greater space for the work, and improved facilities for testing out the eggs. Eight new Prairie State incubators were installed. One coat of paint was given to the buildings.

For housing the deputies who from time to time were assigned to assist in shipping stock from the game farm, the portable house from the smelt field station was set up and furnished, and thus the men were on the grounds and instantly available when needed.

A piece of land was broken up and laid down to clover to furnish green food for the birds. Resodding and the laying out of flower beds added to the appearance of the station. Being located next to the railroad station and near the State road leading from Boston to Plymouth, the game farm attracts large numbers of visitors, especially week ends and holidays. On several occasions there have been as many as 300 or 400 visitors in a day. Many children, too, visit the farm, and the testing room has proved a great attraction. It gives the superintendent an opportunity to teach the children the life history of a bird from the time the eye first shows in the egg, until it is ready to hatch, and to explain to them the danger of disturbing an egg in the nest during incubation. The testing room is no less interesting to the adults than to the juveniles. Early in May a Pathe photographer took pictures of the farm and the broods of young ducklings. The display of the pictures brought many visitors to the farm, who mentioned that they had seen the birds on the screen, and had wished to see the live ones.

*Mallard Ducks.*

The brood stock was 400 ducks from the previous year. They came through the winter well, and were in excellent shape for laying. The first eggs were laid about the middle of March, but as the new cellar was being set in order for work, the incubators were not set until April 2. At that time three were set together, and from that time on they were kept full until 5,560 eggs had been set. When sufficient eggs had been taken for the hatching operations at the station, the shipment of settings of eggs to applicants was commenced, totaling 1,671.

Once hatching started the work moved along rapidly. On some occasions two hatches came off in the same day. The ducklings came so fast that the brood house, equipped with brooders, was not large enough to care for them, and the heating system in the brood house had to be changed to floor heating to take care of the young.

The hatch from the 5,560 eggs set was 4,298, and the per cent of hatch per incubator was remarkable, ranging from the lowest, of 70.2 per cent, to the highest, of 90.7 per cent.

The ducklings grew so rapidly that in order to give the 4,000-odd individuals the space they needed, yards were put out back of the large brood house, and finally the large orchard was fenced off for them. Pools were put in, connected with the water system, making the needed shade and water available at all times.

Shipment of the young birds began June 24. There were 2,156 of the young ducks distributed to applicants for liberation, and 425 retained. These, with 25 wild drakes kept from the previous year's stock, will form next year's brood stock.

The adult ducks, after they had produced enough eggs for the incubators and the distribution lists, were shipped out, also for liberation in the covers, to the number of 339. Ten were freed in the meadow adjoining the farm to see if they would hatch there. Several fine broods were raised, and they were allowed to fly, with others raised near here, in the wild state. The adult birds were sent out in May, in sufficient time for them to nest and bring off a brood in the open. In this connection it is interesting to mention a flock of mallards, now numbering 47, which have established themselves in a river in Marshfield only a few hundred feet from the main highway, where automobiles pass continually. The flock has grown from a few pairs of the wild brood stock released from the game farm one spring, after having given the required quota of eggs. A flock of about 60 wild black ducks has joined them, and remained through November of this year. Another flock of about 40 in North Duxbury, about 5 miles from the game farm, has grown from two pairs which migrated from the game farm before they were caught up and wing-clipped.

### *Pheasants.*

At all our game farms the hatching and rearing of pheasants has been done thus far entirely by the use of bantam hens. This is an expensive method, and as an experiment to test the possibilities of hatching by incubators and rearing in brooders, 600 pheasant eggs were sent to Marshfield from the Wilbraham Game Farm.

The first test showed very poor fertility, 276, or 46 per cent, being taken out then, and among the eggs remaining there were some quite doubtful; 185 were hatched, and 19 more were helped out of the shell, being too weak to struggle out themselves, thus making the total hatch 204. Out of this number, 165 were reared. There were 100 distributed, and the remainder held for brood stock next year.

The young made rapid growth. They were all feathered before they were three weeks old, and had a wing-spread of 14½ inches at that time (two days before they were three weeks old). The regular prepared pheasant feed was not used, but a special mixture prepared by the superintendent.

The whole experiment with pheasants was made under somewhat adverse conditions, for the germs were weak, and the hatch came off at a time when the distribution of ducks was claiming the workers' attention. There were no suitable quarters for the pheasants, and they were reared in the discarded quail pens.

### *Quail.*

No work was done this year in trapping quail to secure a supply of eggs for hatching, for the lack of snow made trapping impossible.

## Report of the Sandwich Bird Farm.

The winter of 1918–19 was remarkable for its mildness, in contrast to the great severity and deep snows of the previous winter. This condition was favorable for bringing the brood stock through the winter in strong and healthy condition for the breeding season. Time not occupied in the daily routine of caring for the stock was spent on construction work, repairs

and preparations for the breeding season, and controlling the ever-present vermin.

Five winter duck pens, 30 by 40 feet, were built inside the large duck yard known as No. 1. They are located on the south side of a steep bank, and so constructed that the bank protects them from the cold north winds. Each pen encloses some upland, beach and open water, and is supplied with spring water issuing from the banks, which keeps the water area open through the coldest winter days. The ducks had no other protection throughout the cold weather.

In duck yard No. 2 bushes and limbs were trimmed away, and low places filled with gravel to elevate the walk above the mud and water.

Duck yard No. 3, located on the shores of Great Pond, was enclosed one-third of its total area, taking in that portion next to and part of the pond. The other two-thirds remains to be finished next season.

Duck yard No. 4, taking in the northeast swamp adjoining the pond, was completely enclosed by a wire fence.

The dams in yards Nos. 1, 3 and 5 were repaired.

The remainder of the eight winter quail houses were completed, painted and placed in position, and the covered winter yards that go with them nearly finished.

A small building used as workshop and storage place for grain and feed, which has been resting on timbers since it was moved from the old location, was set on a cement cellar and foundation, making a suitable storage place for roots, vegetables and incubators.

Repairs on the bantam house were completed, and numerous other small repairs made.

The agricultural operations were carried on by the regular employees of the station, as labor was scarce and impossible to obtain. On April 1 the resignation of one member of the force still further handicapped the work.

### *Native Quail.*

The third season of quail rearing on this location has come and gone. While the results were not so good as last season's, if weather conditions had been seasonable through the latter

part of the summer, instead of the continuous rain and fog, results would doubtless have been satisfactory. While the winter houses for the adult quail were not all completed, several were finished in time to demonstrate that they are satisfactory to the birds.

There were 132 adult quail on hand December 1. Eight were distributed, 8 killed by vermin, and 20 died, leaving 96 breeders at the beginning of the breeding season, — 40 females and 56 males. The first egg was noticed May 19. The total yield was 801 eggs, — 8 were broken, 75 distributed, and the remaining 718 set under bantams.

Of the 718 set, 516 hatched (of which 48 were crushed in the nest); the remaining 202 set were infertile, contained dead germs or were crushed. Two hundred and thirty-four chicks were lost from all causes (vermin, death and disappearance when young), and 234 were raised. This shows a hatching of about 71 per cent of all eggs set, practically the same as last year, and a raising of 45 per cent of what young were hatched, which is 10 per cent lower than last year.

The weather which started in very favorably for young quail, and gave so much encouragement with the first hatchings, suddenly changed to a continuous rainy and foggy spell that lasted until late in the fall. For days and weeks the sun hardly shone, and the death rate was high, such conditions being especially unfavorable for artificial propagation.

No change was made in the method of caring for the young. They showed strong vitality while weather conditions were favorable, but the later hatches came when the severest rainy weather was at its height, which destroyed all chances of improving on last year's record. There were 156 young distributed, and the remainder kept for brood stock.

### *Mexican Quail.*

The 14 Mexican quail on hand December 1, the survivors of the experiment with this species in 1918, dwindled during the winter and spring to 3, 1 female and 2 males. The one female laid 26 eggs. Twelve young hatched, 6 were raised and distributed, and the adults kept for next season. The odd male was killed by vermin in the late summer.

*Wood Ducks.*

The wood ducks have again given considerable encouragement. Seventy-seven adults were placed in breeding yards. More than half were females, and apparently the extra female did not mate. The first eggs were found on April 2, and the last picked up on June 8. The total yield for the season was 477, of which 13 were distributed, 19 broken and the remaining 445 set under bantams. Sixty-three proved infertile, 18 showed dead germs, and 364 hatched, nearly 82 per cent of all eggs set. The mortality of the young varied greatly. One particular lot of eggs, all from one female, gave excellent results. She laid 19 eggs, one of which was infertile, and 18 hatched and were all raised. Other lots went to the opposite extreme. As an experiment several lots were placed under brooders set up in close proximity to the water and then placed in houses so that vermin could be excluded at night. The results with the first brooder were good, but poor with subsequent ones. Another season may demonstrate whether or not it is the most practical way to raise them.

The 364 young hatched are accounted for as follows: 106 distributed, mostly to reservations; 39 kept for additions to brood stock; 177 died from all causes. Thirty-nine disappeared after two-thirds grown, probably from vermin. The disappearance of these latter, as well as the loss of some of the adult ducks, may be somewhat accounted for by the finding in September of a 25-pound mud turtle in the duck yard. There is no way by which this turtle could have gotten into the yard since the erection of the fence, and it must therefore have been in the yard the last two seasons. Thus about 40 per cent were raised from the wood ducks hatched, — about the same percentage as was raised last season. There are on hand for next year's breeding, reckoning both old and young, 101 birds.

*Black Ducks.*

Starting in with 79 ducks on December 1, 78 survived the winter and were placed in breeding yards about March 1, and the first eggs were found April 11. It was difficult to get all the eggs laid, especially the second litters, as almost invariably

these litters were either partially or wholly destroyed or the ducks broken up. Crows, rats and red squirrels were responsible for this, and before they could be controlled the period for second litters had about passed.

The three species of ducks have been found to lay as set forth in the following table: —

| | Black Duck. | Wood Duck. | Mallard Duck. |
|---|---|---|---|
| Number of litters a season, | 2 | 2 | 3 or more. |
| Number of eggs to a litter (old duck), | 9 to 12 | 10 to 17 | Generally lays litters a little larger than the blacks, and sometimes lays continuously. |
| Number of eggs to a litter (young duck), | 7, 8 or 9[1] | 7 to 10[1] | |

[1] First litter.

Out of the 122 eggs that were collected 2 were broken, 8 infertile, 18 contained dead germs and 94 hatched. Twenty-nine of the young were lost from all causes, and the 65 that were raised were distributed. All that were liberated were banded, and up to November 30 only one (No. 189) had been heard from. That duck was shipped to Millis Reservation on October 11, and was shot November 22 by Mr. Talcott Channels in Absecond Bay near Atlantic City, N. J. There remain on hand to carry through the winter 62 ducks, as during the year 2 died, 2 were accidentally killed, 2 were killed by vermin, and 12 old ducks disappeared in late fall, having probably flown away.

### *Mallard Ducks.*

At the beginning of the year there were on hand for breeders for the summer of 1919, 29 mallard ducks. In January, 8 of these were shipped to different persons, and later in the winter and spring 2 were killed by vermin, leaving 19 that were put into the breeding pens. This included the 10 Louisiana wild mallards received from the Marshfield Bird Farm after the breeding season of 1918 for certain breeding experiments. They were placed in the most natural conditions, with no blacks or mallards, but while they appeared to mate, not an egg was laid. This makes the third summer since captured in the wild state

that they have failed to produce eggs. These birds will be kept under observation another year.

From the mallards that mated 119 eggs were secured. The same difficulty was experienced in getting the second litters as with the black ducks. One hundred and seven of the mallard eggs hatched and 74 young were reared, of which 62 were distributed, 8 disappeared in the late fall, and 4 remain on hand, so that at the close of the year 4 young and 19 old birds are available for next year's work. The rearing of mallard ducks is not a part of the regular work of the Sandwich Bird Farm, and what is done is purely experimental.

### *Vermin.*

The vermin problem has considerable bearing on affairs at any game farm. Not only has one to stand the amount of actual damage, but it is also necessary to spend considerable time in what at first appears unnecessary work, such as setting and tending regularly the traps in different sections of the bird yards, oftentimes with no results, or with indifferent success. Then suddenly an attack may come from some quarter where least expected, — a bantam, mother of young quails, may be found dead and partly eaten by a hawk. To be sure, the hawk can generally be caught, for it is almost sure to return to finish its meal; but this does not mend matters for the young quail that seek in vain for their foster mother. The marsh hawks have been unusually troublesome the past season.

Rats were fought day in and day out, and they were killed in such numbers that no record was kept. Efforts are directed toward confining them near the feeding places of the ducks, where they can do the least harm; and when a freshly dug burrow is noticed in the more open land near the quails, the animal is immediately sought out by an employee armed with gun, shovel and gloves, and the rat almost invariably meets his end by one of the three implements. Otherwise he would soon prey on the quails, which, when wing-clipped, are an easy mark for a rat.

But the animal that strikes terror to the adult quail (and incidentally to the game breeder) is the weasel, for that animal kills and continues to kill until it is destroyed. In two nights during the latter part of August a large male weasel cleaned out 18 breeding quail from their summer quarters. For fear he would do more damage every live quail was at once removed from that section, but he was caught that night. With the exception of several bantams, that was the only damage by weasels this season, though 12 were caught.

The vermin score for the past year has been a little less than usual, with perhaps the exception of rats: —

| | | | |
|---|---|---|---|
| Great horned owls, | 6 | Sparrow hawks, | 2 |
| Screech owls, | 4 | Marsh hawks, | 4 |
| Red-tailed hawk, | 1 | Weasels, | 12 |
| Red-shouldered hawks, | 3 | Skunks, | 5 |
| Goshawks, | 2 | Black snakes, | 6 |
| Cooper's hawks, | 18 | Snapping turtles, | 10 |
| Sharp-shinned hawks, | 4 | Several hundred rats. | |
| Pigeon hawk, | 1 | | |

## Report of the Wilbraham Game Farm.

In the course of the year the tenement house was repaired and painted, shop and bungalow clapboarded and painted, and 92 rearing pens constructed. A number of food-bearing shrubs and 500 pines were set out. During the winter months, besides taking care of the stock, repairs were made, so far as possible, and everything put in readiness for the season's work. Approximately 5 acres were sown to grass in the spring, and in the fall 4 acres were cleared of small birches and other undesirable growths, ploughed and sown to winter rye; and 12 acres were ploughed which will be sown to grain and grass later. In addition to the bird-rearing work there have been produced 125 bushels of rye, 50 bushels of shelled corn and 50 bushels of wheat. A quantity of green food for winter feeding has also been grown. Some of the grain was left in the field to supply the escaped pheasants with food, and thus hold them on the farm where in the spring they will rear their broods.

*Pheasants.*

There was a larger loss among the brood stock of pheasants during the winter of 1918 than in the previous year, due, no doubt, to the inability to procure wheat and the consequent necessity of using grain of an inferior quality. The conditions that caused this winter's loss undoubtedly affected the breeding lots through the following summer. When the fiscal year opened on Dec. 1, 1918, the brood stock consisted of 534 pheasants. For the purpose of introducing new blood and to supplement the brood stock 57 pheasants were purchased during December and January. At the beginning of the laying season (April 1, 1919) the brood stock consisted of 411 hens and 133 cocks. At this time a part of the breeders appeared to be in very good condition, but those from the late hatches, and some of the oldest birds (which would not have been retained as breeders except that it was impossible to obtain others from outside parties at this time), were not up to the average. The former were immature and the latter in a weakened state, and some of these died early in the season.

More eggs than usual were consumed by hens as soon as laid. This trouble greatly reduces the average per cent of egg production. Pens are marked, and some of the birds that have formed the habit are liberated, but the next season others have the same destructive habit. Of the many remedies tried none have proven effective for any length of time. This is one of the difficulties for which no satisfactory solution has been found.

The total number of eggs laid was 16,568 (an average of 40 to a hen). One hundred and twenty-five inferior eggs were eliminated; 100 broken in handling; 7,045 distributed to applicants (this included 230 to the Myles Standish State Forest and 600 to the Marshfield Bird Farm); and 9,298 set (1,000 in incubators and 8,298 under hens). As soon as a sufficient number of hens became broody the eggs were removed from the incubator and placed under hens to complete incubation. At the close of the egg-laying period 158 adult pheasants were distributed to applicants.

The number of infertile eggs, and eggs with dead chicks, was large, and only about 58 per cent hatched, — 5,402 chicks in all.

Last year a feeble development of the embryos was noted, causing loss in the shell, and measures were taken to ascertain the cause. This has been a serious problem the last two seasons. Experiments have been made in the matter of moisture, time of cooling and temperature of hatching cellar, but so far results have been far from satisfactory. Due to war-time conditions which prevailed throughout the greater part of the summer, quite a different mash has of necessity been fed prior to the laying season, and it is reasonable to suppose that this is a cause of some of the weakness in the chicks.

The losses in rearing were large, and the number reared to the age of liberation (six to seven weeks) was 1,206. There were distributed 981, and 225 were retained as additions to the brood stock. The young pheasants were liberated, as heretofore, at the age of six to seven weeks. All were in first-class condition. When the heads are fully feathered a young bird will stand as much exposure as an adult. In connection with the distribution of pheasants to the covers, it may be mentioned that 400 young birds were purchased from dealers and liberated.

In rearing the chicks, though the same methods employed last year were followed, the results varied. The heavy rains which occurred during the most critical period for the young birds were responsible for severe losses. The nights especially were exceptionally cold and damp, and mold accumulated on the feed boards over night. Rearing pens had to be moved to new ground every few days. Bantam hens are being used in place of the larger breeds for propagating purposes as fast as it can be accomplished. With this in mind, about 300 bantam chicks have been hatched this fall. All bantam eggs are used for feeding young pheasants.

### *Vermin.*

To rear birds in the open is to invite a constant loss from predatory enemies. Very few foxes had been killed in and about Wilbraham during 1918, compared to other years, and the increase in the fox population in 1919 was very marked. Gray

foxes are most numerous, and are increasing rapidly, and some of both species are living on the product of the game farm at the present time. During the year the following vermin has been destroyed: —

| | | | |
|---|---|---|---|
| Skunks, | 36 | Snakes, | 8 |
| Sparrow hawks, | 5 | Rats, | 30 |
| Cooper's hawk, | 1 | Barred owls, | 2 |
| Red-shouldered hawk, | 1 | Weasel, | 1 |
| Marsh hawk, | 1 | Cats, | 4 |
| Crows, | 22 | | |

## FISH AND GAME DISTRIBUTION.

The distribution of fish proceeded along the lines followed in the previous year. The reduction in the train service in many districts continues to be a source of great difficulty in reaching all parts of the State. The baggage cars are often so completely filled with merchandise that it is only with the greatest difficulty that our men can aërate the fish *en route*. The automobile truck has proved its value, and by means of the one at Sandwich we have been able to distribute a large number of fish at a relatively low cost, and with increased benefit resulting from the time saved while the fish are being transported.

Owing to the lack of funds we have been compelled to utilize our deputies even more extensively than previously, with the result that a number of them were kept out of their respective districts over substantial periods of the year. No relief from this situation can be given until we are able to have on our staff fish messengers who will handle most of the shipments. The stock is moved throughout so many months of the year that men could be given almost constant employment in this work. At other times they could assist in other field work and in law enforcement.

All applications for fish were carefully considered in regard to the suitableness of the waters in which the applicant proposed to plant the fish. This was made possible through the use of our pond and stream records.

The following tables show the amount of stock, both fish and game, liberated in the State during the year: —

*Fish Distribution*

| County. | Brook Trout. | | | | Lochleven Trout. | Rainbow Trout (Fingerlings). | Yellow Perch. | | White Perch (Adults). |
|---|---|---|---|---|---|---|---|---|---|
| | Eggs. | Fry. | Fingerlings. | Adults. | | | Fry. | Fingerlings. | |
| Barnstable, . . . | – | – | 7,500 | 150 | 1,000 | 8,000 | – | – | 7,300 |
| Berkshire, . . . | – | – | 54,400 | 10 | – | 4,050 | 4,500,000 | – | 12,700 |
| Bristol, . . . | – | – | 56,250 | 200 | – | – | – | – | 6,900 |
| Dukes, . . . . | – | – | – | – | – | – | – | – | 5,500 |
| Essex, . . . . | – | – | 63,850 | 308 | – | 4,150 | – | – | 7,600 |
| Franklin, . . . | – | – | 46,750 | 200 | – | 2,000 | 1,500,000 | – | 4,300 |
| Hampden, . . . | – | – | 27,800 | 407 | – | 2,075 | 1,500,000 | – | 10,200 |
| Hampshire, . . . | – | – | 20,000 | 100 | – | – | 3,400,000 | – | 10,600 |
| Middlesex, . . . | – | – | 57,150 | 550 | – | – | – | – | 9,300 |
| Norfolk, . . . | – | – | 48,750 | 300 | – | – | – | 500 | 8,200 |
| Plymouth, . . . | 100,000 | 40,000 | 22,500 | 100 | – | 8,000 | 1,500,000 | – | 10,500 |
| Suffolk, . . . | – | – | – | – | – | – | – | – | – |
| Worcester, . . . | – | – | 82,500 | 605 | – | 2,150 | 2,500,000 | – | 30,500 |
| Out of State and fairs, | 650,000 | – | 100 | – | – | – | – | – | – |
| Totals, . . . | 750,000 | 40,000 | 487,550 | 2,930 | 1,000 | 30,425 | 14,900,000 | 500 | 123,600 |

*during the Year 1919.*

| Pike Perch (Fry). | Small-mouthed Black Bass (Fingerlings). | Pickerel. | Chinook Salmon (Fingerlings). | Atlantic Salmon (Fingerlings). | Horned Pout. | Salt-water Smelt (Fry). | Fresh-water Smelt. | | Totals. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Eggs. | Adults. | Eggs. | Fish. |
| 960,000 | 1,300 | – | 18,600 | – | – | 23,500,000 | 5,000,000 | 3,000 | 5,000,000 | 24,506,850 |
| 1,520,000 | – | – | 19,900 | – | 5,800 | – | – | – | – | 6,116,860 |
| 640,000 | – | – | – | – | 4,000 | 7,500,000 | – | – | – | 8,207,350 |
| 400,000 | – | – | – | – | – | 10,750,000 | – | – | – | 11,155,500 |
| 600,000 | – | – | 280,500 | 3,000 | – | 18,750,000 | 10,000,000 | 3,000 | 10,000,000 | 19,712,408 |
| 480,000 | – | – | – | – | – | – | – | 1,500 | – | 2,034,750 |
| 520,000 | – | 250 | – | – | 11,000 | – | – | 16,700 | – | 2,088,432 |
| 240,000 | 800 | – | 5,200 | – | 12,700 | – | 1,000,000 | 9,000 | 1,000,000 | 3,698,400 |
| 1,280,000 | 400 | – | – | – | 4,000 | 5,000,000 | – | 3,000 | – | 6,354,400 |
| 800,000 | 400 | – | – | – | 13,000 | 2,500,000 | 3,000,000 | 1,500 | 3,000,000 | 3,372,650 |
| – | – | – | 14,000 | – | 9,000 | 15,000,000 | 6,000,000 | 3,000 | 6,100,000 | 16,607,100 |
| 160,000 | – | – | – | – | – | – | – | 1,500 | – | 161,500 |
| 640,000 | 500 | – | 15,160 | – | 3,600 | – | 1,000,000 | 7,500 | 1,000,000 | 3,282,515 |
| – | – | – | – | – | – | – | – | – | 650,000 | 100 |
| 8,240,000 | 3,400 | 250 | 353,360 | 3,000 | 63,100 | 83,000,000 | 26,000,000 | 49,700 | 26,750,000 | 107,298,815 |

*Game Distribution during the Year 1919.*

| County. | Pheasants. | | | Mallard Ducks. | | | Quail. | | Mexican Quail. | Wood Ducks. | | Black Ducks. | White Hares. | Totals. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Eggs. | Young. | Adults. | Eggs. | Young. | Adults. | Eggs. | Young. | | Eggs. | Young. | | | Eggs. | Birds. | White Hares. |
| Barnstable, | 90 | 117 | 9 | 48 | 184 | 20 | 15 | 32 | - | - | 22 | 10 | 24 | 153 | 394 | 24 |
| Berkshire, | 940 | 93 | 16 | 144 | 176 | 32 | - | - | - | - | - | - | 48 | 1,084 | 317 | 48 |
| Bristol, | 285 | 109 | 9 | 84 | 184 | 8 | 15 | 10 | - | - | - | - | 48 | 384 | 320 | 48 |
| Dukes, | - | - | - | - | 112 | - | 15 | 12 | 4 | - | - | - | 36 | 15 | 128 | 36 |
| Essex, | 225 | 181 | 18 | 168 | 192 | 27 | - | 40 | - | - | 12 | 6 | 60 | 393 | 476 | 60 |
| Franklin, | 105 | 92 | 6 | - | 166 | 8 | - | - | - | - | - | - | 36 | 105 | 272 | 36 |
| Hampden, | 780 | 158 | 12 | 132 | 156 | 24 | - | 16 | - | - | - | - | 51 | 912 | 366 | 51 |
| Hampshire, | 1,005 | 146 | 17 | 72 | 198 | 32 | - | - | - | - | - | - | 42 | 1,077 | 393 | 42 |
| Middlesex, | 645 | 125 | 18 | 144 | 190 | 34 | 15 | 6 | 2 | - | - | - | 42 | 804 | 375 | 42 |
| Nantucket, | - | 14 | 6 | 24 | 80 | 4 | - | - | - | - | - | - | 42 | 24 | 104 | 42 |
| Norfolk, | 255 | 142 | 15 | 120 | 144 | 24 | - | 24 | - | - | 24 | 24 | 48 | 375 | 397 | 48 |
| Plymouth, | 1,310 | 127 | 12 | 309 | 228 | 43 | 15 | - | - | - | 40 | 25 | 36 | 1,634 | 475 | 36 |
| Suffolk, | 105 | - | 2 | 24 | - | - | - | - | - | - | 2 | - | - | 129 | 4 | - |
| Worcester, | 675 | 169 | 17 | 330 | 208 | 88 | - | 16 | - | 13 | - | - | 72 | 1,018 | 498 | 72 |
| Out of State, | 625 | 8 | 1 | 72 | - | 3 | - | - | - | - | 6 | - | - | 697 | 18 | - |
| Totals, | 7,045 | 1,481 | 158 | 1,671 | 2,218 | 347 | 75 | 156 | 6 | 13 | 106 | 65 | 585 | 8,804 | 4,537 | 585 |

## MARINE FISHERIES.

Seldom have the marine fisheries, the State's oldest industry, passed through a more eventful year than that of 1919 just closed. Nevertheless, speaking broadly, the term "fairly successful" can be reasonably applied to the industry as a whole. The receipts have been large, and fish have been in good demand. The high prices of the previous year, however, cannot be said to have been generally well sustained, and there were certain noticeable instances where the prices fell to a low level. Certain features which appear to us to be the outstanding high points in the marine fisheries of the past year are as follows: —

Strikes and labor difficulties with some of the various labor unions with which the men of the fishing fleet, and some of the shore workers, are affiliated.

Court action, brought about by both Federal and State authorities, against many of the fresh-fish dealers on the Commonwealth Fish Pier at Boston.

Report of a joint special recess committee of the Massachusetts Legislature, following an investigation of the fish industry of the Commonwealth.

Very slight decrease in the catch of fish, despite the many labor, legal and other handicaps under which the year's fishery was conducted.

Extension westward of markets for fresh fish.

Increased demand of 1918 for fish continued, if not exceeded, in some lines.

Continued decline of the sailing fishing fleet by selling of crafts, and little replacement by building new ones.

Increase in the fleet of steam otter trawlers.

Introduction of electricity as motive power to fishing craft (the first instance on record in this country).

Introduction of a system of inspection of fresh and frozen fish by a State inspector of fish.

Inception of the use of aircraft as an aid to the fishermen by locating from great heights schools of fish not visible from the

masthead of a fishing vessel, and communicating that knowledge to the fleet or to shore stations.

The re-entry of old T Wharf, Boston, as a wholesale fish landing place.

### The Deep-sea Fisheries.

The methods followed and the fishing grounds used by the Massachusetts fishing fleet during the past year differed in no appreciable respect from those of 1918.

The mackerel seining and netting fleet fared south in the early spring as usual, the crafts of the former division going as far to the southward as Cape Charles, while the netters began their operations off the New Jersey coast. Both divisions were fortunate in making good catches, following the fish in their northward run, and landing their fares at New York and Newport, R. I. Especially good was the luck of the netting fleet, and it is doubtful if, taking it "full and by," this fleet of little vessels ever fared better, as far as amount of landings and high prices are concerned.

The catch of the mackerel seining fleet on the "Cape Shore," or Nova Scotia shore, will rank with the best, although on account of the large fleets piling in together the price obtained for the fresh mackerel was not all that could have been desired, while, on the other hand, the salted product brought what is claimed to be the highest price ever obtained in this line for "Cape Shore" fish.

From the arrival home of the seining fleet from the "Cape Shore," and the diversion (as usual) of the larger craft of the netting fleet to sword fishing, the mackerel season could not exactly be called "prosperous." The "Cape Shore" fleet, after arriving home about the middle of June, turned its attention southward around No Man's Land and the South Shoal, South Channel and Georges grounds, and for a while met with a fair degree of success. But the strike of the fishermen's union tied up the whole fleet from July 3 to August 23, practically the "cream" part of the season, and when at last matters were adjusted and they set sail, it was to meet with rough and foggy weather, and, worst of all, they had "lost run" of the schools. The seiners scurried over all the coastal grounds, also South

Shoal, South Channel and Georges, and the Maine coast and Bay of Fundy were thoroughly combed, but it seemed as though the "jig was up." True, some good catches were made and some craft did well, but for the fleet as a whole the success, if success it can be termed, was very limited, and the season ended with a decreased catch as compared with 1918.

The Massachusetts catches of fresh and salted mackerel from Dec. 1, 1918, to Nov. 30, 1919, inclusive, and for the corresponding period of the previous year, were as follows: —

| | Dec. 1, 1918, to Nov. 30, 1919. | Dec. 1, 1917, to Nov. 30, 1918. |
|---|---|---|
| Salt mackerel, | 7,007 | 13,030 |
| Fresh mackerel, | 55,375 | 67,931 |
| Totals, | 62,382 | 80,961 |

Owing to the unusually open winter of 1918–19 the winter haddock fleet prospered thereby to a large degree, for quick and large trips were the rule; and owing to the increased demand good and even high prices ruled, so the sway of the haddocker was one of golden record.

The salt bank codfishing fleet, both trawl and dory handline, was pitifully small as compared with the halcyon days of but a few years back, when 40 and 60 sail comprised the fleet. Last year the figure 10 would be more than enough to cover both. Suffice to say that all the vessels engaged did well, and the season for them as a whole was remunerative.

The swordfish fleet, in the summer months usually devoted to that fishery, found very high prices awaiting every fare, and the total catch was fair, although not approaching that of the previous season, as the "heart" of the days of operation was practically denied these energetic fishermen by reason of the strike of the union fishermen, which tied up the fleet during the best part of the money-making season.

No craft went on flitched halibut voyages in 1919, the enormous expense and the long time entailed (from five to six months in a trip), with the chance of big money for vessels on short trips in other lines, having great weight, no doubt, with the vessel owners.

The fresh halibut fleet enjoyed perhaps the apex of prosperity of all the crafts engaged in the 1919 fishery while they were going, but this line, like the rest, found the union fishermen's strike embargo laid heavily on them in what would have been their most lucrative weeks. Notwithstanding this, this remarkably active fleet succeeded in increasing its catch record over last year, and received for its labors the highest prices ex-vessel ever known.

The fishermen's strike hit as hard, perhaps, as anywhere on the fleet of "shackers," crafts that fare to the eastern banks for trips combining fresh and salted fish, the former to go to the splitting knife to be converted into salt fish eventually. Nevertheless, before and after the strike, this line of fishing was marked by large and sometimes record fares, hence prosperity was tempered only by nearly two months of lost motion.

The fleet which made short and quick trips, the "market fleet," so called, outside of the time lost during the strike, did well, making good catches and being greeted at times with prices such as to cause the tired face of the most hardened old fisherman to seam with inward joy, although there were marked periods when prices were unusually low.

The season for the little boats which stray not too far from shore was also one of profit, but of course it must be taken into account that many, although not all, of these had an enforced vacation in the "money months" of midsummer because of the strike.

*Gloucester Fish Report.*

The following table gives at a glance the Gloucester fish story for the year. In spite of the strike of the fishermen's union in July and August, just the time of year when generally the largest quantities of fresh and salt fish are landed at that port, the receipts in other months indicated a sufficient gain in groundfish to show, even with the strike handicap, an increase over similar 1918 receipts, and as a whole, about an equal total with last year, with the exception of fresh herring, which are caught in the spring and early summer on the shore fishing grounds. The decrease in catch of these fresh herring is about

10,000,000 pounds, which it will be noticed is practically the amount that the Gloucester receipts fell behind the total catch of last year.

*Gloucester Total Receipts.*

| | Dec. 1, 1918, to Nov. 30, 1919. | Jan. 1, 1918, to Nov. 30, 1918 (Eleven Months). | 1917. |
|---|---|---|---|
| Salt cod, | 3,004,673 | 4,449,825 | 6,439,642 |
| Fresh cod, | 28,087,983 | 27,977,652 | 20,666,852 |
| Halibut, | 306,570 | 610,123 | 875,977 |
| Haddock, | 16,127,331 | 8,568,578 | 2,790,801 |
| Hake, | 779,840 | 581,222 | 863,758 |
| Cusk, | 779,972 | 627,016 | 597,756 |
| Pollock, | 18,524,658 | 16,154,131 | 9,095,363 |
| Flitches, | 8,476 | 6,535 | 41,002 |
| Not product of American fisheries, | 25,733,450 | 27,073,565 | 32,209,601 |
| | 93,352,953 | 86,048,647 | 73,580,752 |
| Fresh mackerel, | Pounds. 302,188 | Pounds. 1,885,122 | Barrels. 10,713 |
| Salt mackerel, | Barrels. 7,457½ | Barrels. 12,000 | Barrels. 24,349 |
| Fresh herring, | Pounds. 1,777,844 | Pounds. 11,204,480 | Barrels. 50,229 |
| Salt herring, | Barrels. 32,231 | Barrels. 39,927 | Barrels. 41,268 |
| Frozen herring, | – | Pounds. 187,205 | Pounds. 487,946 |
| Cured fish, | Quintals. 12,265 | Quintals. 20,037 | Quintals. 43,569 |
| Miscellaneous: — | | | |
| Small boats (estimated), | Pounds. 5,000,000 | Pounds. 7,000,000 | Pounds. 8,250,000 |
| By rail, | 23,410,979 | 22,870,000 | 13,260,000 |
| Flounders, | 200,000 | – | 480,000 |

*Summary.*

| | Pounds. |
|---|---|
| Total, 1917, | 131,026,356 |
| Total, 1918 (to November 30), | 143,442,954 |
| Total, Dec. 1, 1918, to Dec. 1, 1919, | 133,638,765 |

## *Boston Fish Report.*

The following résumé of the fish year at the port of Boston is furnished by Secretary F. F. Dimick of the Boston Fish

Bureau, who is thoroughly posted on matters pertaining to the fisheries and fish business of this premier fresh fish port: —

The year 1919 has been quite a successful one in the fish business, but the restlessness of labor and the strikes that have taken place during the year have cut into the profits, especially in the vessel fisheries. There has been a good demand for fish, and a large amount has gone into consumption. A feature of the year was the demand from the West, where Boston dealers have been introducing the haddock to the public by advertising and sending representatives into that part of the country to build up a trade.

There has also been a big demand for finnan haddies the past year, owing to the large receipts and the lower prices that have ruled for haddock.

The season on Cape Cod has been a poor one. The catch of mackerel in the traps was very light. The catch of squid was light. There was a good catch of whiting, but other kinds of fish were in light supply.

Halibut have been in better supply from the eastern vessels, but in light supply from the West.

The season on eastern salmon was the poorest for many years.

The catch of mackerel was light, largely owing to the fact that at the time of the year when the mackerel are caught on the shore the fleet was tied up by a strike of the fishermen. The "Cape Shore" catch was good, and all the vessels came home with fine catches.

The catch of swordfish was light, but receipts of these fish from Nova Scotia increased.

The table showing the landings at the port of Boston follows: —

| | Dec. 1, 1918, to Nov. 30, 1919. | Jan. 1, 1918, to Nov. 30, 1918 (Eleven Months, approximately). |
|---|---|---|
| Codfish, | 32,265,992 | 36,457,622 |
| Haddock, | 61,504,416 | 47,752,660 |
| Hake, | 2,860,160 | 2,330,643 |
| Pollock, | 3,846,345 | 4,130,341 |
| Cusk, | 795,646 | 981,665 |
| Halibut, | 1,353,704 | 734,992 |
| Mackerel, | 4,000,513 | 6,412,715 |
| Miscellaneous, | 4,559,830 | 4,840,002 |
| Totals, | 111,186,606 | 103,640,640 |

*Some "Prosperity Trips."*

In the fisheries, as in many other lines of natural resources, pursuits, and trade and manufacturing lines, there was much unusual evidence of prosperity. The reports of many of the vessel owners show that the past year was one of profit, generally speaking, and these mentioned were not the only ones to share in the prosperity of the yield of the great sea farms, for as the laborer is worthy of his hire, and as the workers on the land farms are reported as profiting by the large crops and high prices, so did the sea farmers, the fishermen, share, and share well, in the harvest which was the result of their manual labor and skill as seamen.

The object of the following paragraphs is not to select entirely those who did the best in every line of fishing, who led all the rest, but to record some of the high points, that some idea may be gained, by those not entirely familiar with the fisheries, of the reward garnered by some toilers of the sea. It is fair, also, to warn the reader that the money-making trips recorded below are not fairly indicative of the money made by the fleet as a whole. Indeed, they are above the average, and while the average was high, there were many crafts and crews whose year's work would not make interesting reading from a big stock and share standpoint, and whose books barely balanced, if, indeed, they did not show something on the wrong side of the ledger.

What is believed to be the largest single stock ever made in the fresh haddocking fishery by a sailing vessel was realized by schooner "Joffre," Capt. Wallace Bruce, who on a trip landed at Boston November 5, stocked $10,057.31. The "Joffre" was out just ten days, her stock averaging over $1,000 a day. The crew has as a result of their work stocked $281.75 to a man.

Schooner "Killarney" of Gloucester arrived at Boston, Nov. 15, 1919, with a fare of 130,000 pounds of fresh fish. It is the first trip of the craft under Capt. Ernest Parsons, she being out only since November 8. The crew's part was $280 to a man. The stock on the trip, which amounted to $9,691.49, was one of the largest on record in the winter haddock fishery.

On December 8 the "Killarney" arrived at Boston again with another fine fare of fresh fish, on which $9,000 was stocked, and the crew shared

$220 each. For the period of one month, from November 8, the craft made the remarkable stock of $23,000.

Among those whose work stands out prominently is Capt. Joseph J. Mesquita of the schooner "Arethusa." This vessel, on July 11, settled for her shacking trip landed that week, stocking $6,300, on which each of the crew shared $148.95. The vessel was out but three weeks. Captain Mesquita's total stock in five months, or, more exactly, since February 1, was $41,768.38, on which each of the crew shared $908.37.

Capt. Jeff Thomas, in the new schooner "Maréchal Foch," is another who has done well. The vessel has made three trips from May 8 to early in July, when she went into commission. The stock for these trips was $15,369, on which the crew for their two months' work have shared $311. Captain Thomas commanded the schooner "Benjamin A. Smith" haddocking last winter, and rolled up a fine stock on this vessel. From Oct. 10, 1918, to April 7, 1919, the vessel stocked $61,160, and each of the crew shared $1,284. This made Captain Thomas' stock in nine months $76,529, and the share $1,595.

Capt. John G. Stream, in the schooner "Rhodora," from February 1 to early in July made the fine stock of $32,273.58 in the fresh halibut fishery, and each of the crew has shared $861.80.

The schooner "Republic," Capt. Peter Dunsky, also made a fine stock in the same branch of the fisheries. From February 1 to early in July this vessel stocked $24,392.24, and each of the crew has shared $533.52.

A record of good stocks and shares would not be complete without that of the schooner "Acushla," commanded by Capt. Iver Carlson. From April 20 to June 25 this vessel, in the fresh halibuting branch, stocked $25,381.90, and each of the crew for his two months' work has received $584.48.

On the trip to the "Cape Shore" for mackerel, Capt. Wallace Parsons, in the schooner "Saladin," stocked $9,948.04, on which the crew shared $210.58. With his southern trip this made his total stock $13,013.71, and the crew's share $263.12.

The schooner "Mary F. Curtis," Capt. Lemuel Firth, had a total stock mackereling out south and to the "Cape Shore," of $16,813.83, and the crew's share of $348.90 was a result of seining trips from April 25 to July 4.

Capt. Percy Firth in the schooner "Norma," from April 25 to June 17, in mackerel seining, stocked $15,049.60, and each of the crew shared $301.08.

The little mackerel-netting schooner "Kitty A.," Capt. Paul Dorey, in five nights of setting her nets for mackerel secured such good hauls and fine prices that each of the small crew shared $538 each, clear of all expenses for their five nights' work.

The schooner " Squanto," Capt. Guiseppe Strescino, on a ten days' winter haddocking trip, stocked $7,724, on which each man of the crew shared $279 clear of all expenses.

The schooner "Ruth and Margaret," Capt. Val O'Neil, on a ten days' haddocking trip to Western Bank, stocked $8,715, the crew sharing $234 each, clear.

The schooner "Natalie Hammond," Capt. Charles Colson, for a year's return for fishing, part of the time haddocking and part of the time halibuting, stocked $85,328.83, and each of the crew shared $2,426.20 clear, — one of the best financial showings ever made for a double-dory craft.

The schooner "Elmer E. Gray," Capt. Matthew Sears, haddocking, at just one set of her trawls took 43,000 pounds of fish, and rushed to the Boston market. The resultant stock was $2,832, and each man of the crew shared $102.

The schooner "Cavalier," Capt. Robert B. Porper, in the spring of 1919, stocked $10,624 on a single halibut trip, the largest stock, with one exception, ever made in this branch of the fishery. The craft was out twenty-one days, and the crew's share was $225.81, while some who had hand-line fish shared $243.50.

The schooner "Frances S. Grueby," Capt. Enos Nickerson, in the haddock fishery, from trips landed from August 23 to October 23, stocked $34,000, and each one of her crew profited to the extent of $770 clear.

The schooner "Imperator," Capt. Robert Wharton, on an October halibut trip of short duration, stocked $9,300, the crew sharing, each, $229 clear.

The schooner "Ellen F. Marshall," Capt. Manuel Goulart, on a haddock trip late in September, stocked $6,800, and the crew shared $210 clear.

The schooner "Hazel R. Hines," Capt. Fred Morrissey, one of the few remaining crafts engaged in the salt banks trawl codfishery, and arriving home in June, weighed off 331,350 pounds of salt cod, on which the fine stock of $17,382 was made. The sharesmen of the crew each received $555.51, while the average share was $338.45.

### *Electrically Driven Otter Trawler.*

The past quarter century has seen marked advances in marine fishing activities, the introduction of gasoline engines as auxiliary motive power, and also the coming of the steam otter trawler. Now in the latter class of fishing craft has arrived the crude oil, "C–O," engine, and within only a few months a craft, the only one of her kind in our fisheries, equipped with a heavy-oil engine with electrical transmission, and also her auxiliary equipment electrically driven.

This interesting craft, the "Mariner," owned by the Marine Trawling Company of Gloucester, has recently completed very successful trial trips off New London, which were watched

with great interest by the marine fishing world. The craft was built by Arthur D. Story of Essex, and her machinery was installed by the New London Ship and Engine Company of Groton, Conn., and the General Electric Company of Schenectady, N. Y. She is of wooden construction and has the following dimensions: —

Displacement, 500 tons.
Length overall, 150 feet.
Breadth, 24 feet 3 inches.
Mean draught, 11 feet 9 inches.
Power of Diesel engine, 480-shaft horsepower.
Number of engines, 2.
Number of propellers, 1.
Power of electric motors, 400-shaft horsepower.
Output of electric generators, 165 kilowatt at 125 volts.
Power of trawl motor, 100 B. horsepower.
Engine speed, 350 revolutions per minute.
Propeller speed, 200 revolutions per minute.
Propeller dimensions, 94-inch diameter by 68-inch pitch.
Ship's trial speed (at 195 revolutions per minute), 10 knots.
Cruising radius at 10 knots, 6,000 nautical miles.
Cruising radius at $\frac{3}{4}$ speed, 9,000 nautical miles.
Fuel tank capacity, 17,000 gallons (425 pounds).

"Motorship," in a very detailed description of the craft, said in part: —

The propelling machinery consists of twin eight cylinder, four-cycle, Nelseco Diesel engines, each rated at 240 B. horsepower at 350 revolutions per minute. These engines are direct-connected to two 165-kilowatt, 125-volt generators. . . . Another important point in connection with this installation is that a large motor, that is to say, about 100 horsepower, is required for the winch for handling the trawl. . . .

The official trial of the "Mariner" was held on Saturday, Nov. 29, 1919. Dock trials had been held previously, but this was the first real test at sea, and the ship lived up to expectations in every way. The first test was more of an endurance trial, during which the engines were operated at increasing power, finally working up to full power and speed, which was maintained for several hours. The speed of the boat was a little over 10 knots, and was obtained at about 195 turns of the three-bladed cast-iron propeller. The "Mariner" ran very steadily, and the general absence of vibration was very noticeable. In fact, at any part of the ship, except in the immediate vicinity of the engine-room, there was nothing to indicate the presence of any power in the vessel. . . .

*Locating Fish Schools by Aircraft.*

In a few years it may be a matter of newspaper report that —

The fishing schooner "Belle of the Sea" arrived to-day with a large catch of fresh mackerel, estimated at 50,000 pounds. The fish were almost alive when landed, for they had been caught but a few hours before off Cape Cod. As prices are high the men of the "Belle of the Sea" will profit well for their few hours' work. For their fattened pocketbook they can thank the sharp-eyed chaps of the Naval Aircraft Division, attached to the United States Bureau of Fisheries as fish school scouts. The men engaged in that work are mostly veteran aviators of the World War, whose experience in spotting and potting the Hun undersea terrors is now being turned to advantage in these peace times in assisting the fishing fleet which was so sadly ravaged by these German underwater raiders, by locating for them under water schools of fine fish which they otherwise could not find, and thus enabling them to make quick and profitable trips, and at the same time provide the fish-eating public with an increased supply of fresh fish.

The matter of seeking fish by airplane was first suggested by Secretary Wilmot A. Reed of the Gloucester Board of Trade, and was taken up by that body and by the Master Mariners Association of Gloucester as a valuable aid to the fisheries, if feasible. Representations were made to the Bureau of Fisheries, and a committee sent to Washington to talk the matter over with Dr. Hugh M. Smith, Commissioner of Fisheries, who expressed the belief that the experiment was worth trying, and intimated that the Bureau would take up the matter, which was soon followed by action. A seaplane was secured from government sources for the use of the Bureau, and W. W. Welch of the Bureau recently made a trial trip in the sky flyer, a high-powered affair, off Cape May, N. J. On this experimental trip Mr. Welch actually located schools of fish beneath the surface which could not have been seen from the deck of a vessel, and directed a number of fishing crafts to them. He reported the experiment a success, and in his report to the department said, in part: —

At the time of flight no schooling fish were breaking water upon the surface, and none would have been visible from the deck of a ship. The plane ascended rapidly to about 800 feet, and most of the trip was made at that altitude, and at an average speed of 75 miles an hour.

Few schools of fish were seen at first, but as my eyes grew accustomed to the conditions many small schools of menhaden were observed, all moving at some depth, and none of them breaking water. From a comparison of other objects seen at known depths it is estimated that the depth of the schools varied from 2 to 10 feet, or possibly more.

A school of porpoises was seen and could be followed under water. The deeper the school the more necessary it was to approach it in order to see it. When the sun's rays were reflected from the surface it was impossible to see anything.

As to the aircraft being of assistance to fisheries research, Mr. Welch says: —

A flight over any given region in which fisheries research work is to be carried on would make clear at once the interrelations of land and water and the character and extent of tidal currents, which may be distinguished by their color, the eddies along their courses, and by their reaction to the wind.

Besides the general value of such observations, in no other way could such a clear idea be obtained of the abundance or scarcity of fish schooling species, and the characteristic appearance of the schools, as well as of all other surface forms of life. The most evident opportunity for the practical use of aircraft in the commercial fisheries at the present time lies in their employment as scouts for the fishermen.

The chief service rendered would be the notification of the fishermen of the general location of the schools, and it would require actual trial and practice.

### *State Inspection of Fresh and Frozen Fish.*

Under the provisions of chapter 351, General Acts of 1919, steps were taken to regulate the sale and cold storage of fresh food fish. The act provides for the appointment of a State inspector of fish and deputy inspectors, to be under the jurisdiction of the Division of Fisheries and Game of the Department of Conservation. The principal regulations, as set forth in the act, are as follows: —

Section 1. All fresh food fish shall be graded before it is offered for sale or placed in cold storage. There shall be three grades. The first grade shall include only such fish as are known in the trade as "new fish", and fish of the first grade may be sold as "number one fish", or "shore fish", or under any other truthful designation. The second grade shall include all other fish which are in suitable condition to be offered for sale as fresh fish, and fish of the second grade may be sold as "number two fish" or "off shore fish". The third grade shall include all fish which are suitable for

splitting and salting, or otherwise preserving, but are not suitable for sale as fresh fish, and fish of the third grade shall be sold as number three fish.

SECTION 2. It shall be unlawful to sell or offer or expose for sale fish which have been graded as number two fish, unless at the time of such sale, or offering, or exposing for sale, it shall be clearly stated or made to appear by suitable designation that they are number two or "off shore" fish.

SECTION 3. It shall be unlawful to sell or offer or expose for sale at retail, for food, number three fish, or to sell or offer or expose the same for food, except for splitting and salting, or otherwise preserving.

SECTION 4. It shall be unlawful to place in cold storage any fresh fish not previously graded as number one or number two fish. All food fish, unless deposited in bulk, shall, when deposited in cold storage, except in private freezing plants, be plainly marked with the date of receipt on the containers in which they are packed, and, if deposited in bulk, shall, at the time of removal from cold storage, be plainly marked with the month and year of receipt on the containers in which they are packed.

SECTION 5. It shall be unlawful to sell or to offer or expose for sale fish which have been held in cold storage without notice to persons purchasing or intending to purchase the same that such fish have so been held, nor without the conspicuous display of a sign "Cold Storage Fish"; and it shall be unlawful to represent or advertise or sell as fresh, fish which have been held in cold storage.

SECTION 6. It shall be unlawful to sell or offer or expose for sale at retail cold storage fish more than forty-eight hours after their receipt by the retailer from cold storage, unless they are received by the retailer in the frozen state and sold frozen to the consumer, except that during the period from November first to March thirty-first in each year, halibut, salmon, swordfish, steak cod and pollock may be sold and offered or exposed for sale at retail during a period of one week after their receipt by the retailer from cold storage, provided that they remain in the frozen state until within forty-eight hours of the time of sale.

SECTION 7. It shall be unlawful to alter, deface or remove any marking on cold storage fish which shows the date of their receipt in cold storage until after the fish are finally withdrawn for the purpose of immediate sale for consumption.

SECTION 8. It shall be unlawful to transfer the ownership of fish in cold storage without previously making known to the purchaser of the same the date on which they were originally placed in cold storage.

SECTION 9. It shall be unlawful to deposit, or cause to be deposited, in cold storage fish received from any other state or country which have previously been in cold storage in this commonwealth, or which have been in cold storage in any other state or country, for a period exceeding six months, unless, at the time of deposit, such fish are plainly marked with the date of their original deposit in cold storage in this commonwealth or in any other state or country.

On Nov. 5, 1919, His Excellency the Governor appointed Arthur L. Millett of Gloucester, inspector of fish. Mr. Millett has been a member of the Board of Commissioners on Fisheries and Game during the past four years.

*Need of an Experimental Fishery Station.*

This subject of a permanent experimental fishery station began to assume substantial shape early in November, 1919, when Dr. Hugh M. Smith, United States Commissioner of Fisheries, in a talk before the Gloucester Board of Trade, left with his hearers the thought that such a station would be of great importance to the fisheries. Immediate action was taken by the municipal council of Gloucester by the passage of a set of resolutions favoring the establishment of such a station. The Board of Trade took similar action. The matter was placed in the hands of Congressman W. W. Lufkin, who caused the following bill to be introduced in Congress: —

A Bill to authorize the Establishment of a Fishery Experiment Station on the Coast of Massachusetts.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress Assembled,* That to aid in acquiring and diffusing among fishermen and those engaged in the fishery industries useful and practical information connected with the fisheries, the method of capture of fishes, the handling, curing, and preparing of fishery products, and the methods of utilizing fishery products heretofore unutilized or wasted, and to conduct scientific investigations and experiments respecting the principles and application of science in relation to the fisheries, the Secretary of Commerce be, and he is hereby authorized, empowered, and directed to establish a fisheries experiment station on a site to be selected by him on the coast of Massachusetts: Provided, That the cost of said station, including the site, buildings, wharves and other structure appertaining thereto shall not exceed $125,000.

This station, if established, would not be a step in the dark or in the nature of an experiment, for already for the past two years fisheries scientists, under the direction of the United States Bureau of Fisheries, have pursued various valuable experiments at a temporary station at Gloucester in the laboratory of the George Perkins & Sons branch of the Gorton-Pew

Fisheries Company. The officials of the Bureau of Fisheries briefly describe their work for the year thus: —

During the past summer the Bureau continued, at the Perkins Laboratory in Gloucester, the investigation of the preservation of fish by methods of dehydration. The investigations have shown the feasibility of preparing fish for early consumption by desiccation, but it remains to perfect methods which will permit of the storage of the product for long periods of time and under different climatic conditions. Other studies pursued during 1918 have related to the cause of the reddening of salt fish. The organisms which give rise to both the red and the pink coloring of salt fish have been isolated and many of their characteristics determined. Further studies and experiments will be required before economic and fully practicable methods of prevention can be suggested.

During 1919, periodically in April, May and June, and steadily from July to September, the Bureau conducted investigations, at the plant of the Frank E. Davis Company in Gloucester, on the development of a method of recovering brine and other products of value from old pickle in mackerel barrels. It was found that brine could be recovered, and that a precipitate which might have value for a number of different purposes is left. The method is now being used at the plant of the Frank E. Davis Company in a commercial way. This plant is, however, intended as a commercial scale experiment, and public announcement has been withheld until its performance indicates entirely satisfactory results.

Further work was conducted at Gloucester in the Perkins Laboratory on the salting of fish by improved methods of salting. This is in continuation of work conducted in Florida, North Carolina, Washington, Maryland and elsewhere. This work was directed principally to methods of causing more rapid penetration of brine into fish during the salting process and of preventing the rusting of the fat, and in general producing an improved product where the conditions of salting are particularly unfavorable, as in warm weather. This work has been brought to a practical conclusion, and an effort is now being made to establish this method in Florida, where the climate is unsuitable for salting fish by any other known method. The results achieved in Gloucester indicate that fish may there be satisfactorily salted in the warmest weather and produce an entirely satisfactory product.

*United States Fisheries Association.*

Commissioner Arthur L. Millett represented the Board at a meeting in New York City Feb. 14 and 15, 1919, when representatives of the commercial fisheries interests met to organize into an association, to be known as the United States Fisheries Association. Its membership includes wholesale producers and distributors of fresh, salted, smoked, canned or preserved fish,

and retailers and supply concerns furnishing provisions, gear or equipment to any branch of the industry are also eligible. This association bids fair to be an important factor in the future of the commercial fisheries.

The association is organized to —

Bring about co-operation and a better understanding of conditions as between producers and distributors.

Provide a place to which members can appeal for a solution of commercial problems, misunderstandings and difficulties.

Provide a clearing house for valuable trade suggestions, and act as arbitrator on mutual request.

Stimulate all agencies which can be used to advertise and increase the consumers' demands for fish.

It aims, further, to work actively for the benefit of all branches of the industry in certain important directions, such as improving distribution and transportation methods; the removal of pollution problems confronting the fishing districts; securing government co-operation in extending the distribution and use of fish in the nation's food supply so as to make the commercial fisheries of maximum usefulness to the people of the country; and the recognition by all governmental agencies that the fishermen producers of the United States are pursuing a calling of equal ultimate importance to, and more precarious than, agriculture, and are entitled to the same broad measure of encouragement and support that is now extended to agriculture. It also aims to guard the fisheries interests against adverse legislation.

Commissioner Millett also attended the first annual convention of this association at New York City on September 26 and 27.

Both meetings were marked by attention to matters of importance to the fresh, salted and preserved fish industry in which Massachusetts is the leader.

The association has a membership of over 700, and is doing a really valuable work relative to production, transportation and distribution of fish, as well as in keeping a watchful eye on and making itself heard on legislative matters pertaining to the industry in whole or in part.

## The Lobster Situation.

The whole lobster situation continues to show a healthy, gradual improvement. This statement is made on a composite reading of the deputies' reports for the various districts in which lobster fishing is carried on. They bring out the noticeable and very interesting fact that in sections not far removed from each other the results of the season were at wide variance. Still, a close reading of all the reports tends to show an increase of catch, a better respect for the lobster laws, a gain in membership for the lobstermen's associations, a marked increase in "shorts" and "seeders," and the appearance in some waters of a noticeable number of small lobsters of from 3 to 5 inches in length. It is true that the progress noted is slow, but the improvement seems marked and sure. It is due primarily, it would seem, to three things: —

First, the realization by the lobstermen themselves that catching and selling short and seed lobsters meant the ruin of their business, the ruin of the industry, and the extermination of the lobster in the waters of the State, following which awakening they formed, on the suggestion of the Fish and Game Commission, associations whereby they bound themselves not to take or market shorts and seed lobsters, and, if possible, to prevent others from doing so. With this may be linked the lobster license law, advocated by the lobstermen themselves, which in effect puts the violator of the law, if caught, "out of business."

Second, the persistent search for violators which is kept up all along the coast by the deputies of the Commission, which has resulted in bringing some of the worst offenders to justice, and has given to the law-abiding lobstermen the feeling that their interests and their welfare are being zealously protected by the Commission.

Third, the policy of the Commission, pursued for the past three years, of distributing, in the districts where the lobstermen are living up to the laws, the short and seed lobsters confiscated from Nova Scotia shipments. This policy, according to the lobstermen, is showing good results, and has considerable to do with the increased catch and the restocking of the fishing grounds. This year, besides the lobsters thus seized and

planted, the lobstermen received an unexpected legacy when the Maine lobster smack "Gertrude Mabel," while bound from Lockport, N. S., with 18,000 fine lobsters in her well, had the misfortune to pile up on the uncompleted Sandy Bay breakwater off Rockport on May 23, 1919. The unfortunate craft struck when a storm was going and the seas were rough. Consequently, she soon pounded a hole in her hull, slid off, and sank in deep water. The craft was afterwards raised, floated and repaired, but the whole 18,000 lobsters went to increase the stock in that vicinity, having found their way to liberty through the hole which the breakwater rocks gnawed in the hull.

This year the number of shorts seized from Nova Scotia shipments and planted in State waters was about 18,000 as against 8,000 the previous year and 37,000 in 1917. The number this year would have been much greater but for the fact that the Nova Scotia open season, formerly five and a half months, was reduced to three months by the new Canadian lobster regulations. Besides the planting of shorts, the Commission has expended $2,000 for the purchase from the Boston wholesale dealers, at market price, of lobsters which become "berried" in the storage cars. These, too, were distributed on the lobster fishing grounds.

Storms caused the lobstermen to lose quantities of fishing gear the past season, and consequently much loss of fishing time. On the other hand, prices ranged higher than in 1918.

Statistics of the lobster fishery of 1919 will be found in the back part of this report.

The following table shows the figures of the catch over a period of thirty-one years, and is therefore of historical interest: —

*Massachusetts Lobster Fishery.*

| Date. | Fishermen. | Traps. | Number of Lobsters above 10½ Inches. | Egg-bearing Lobsters. | Average Catch per Pot. | Ratio of Egg Lobsters to Total Catch. | Average Ratio of Egg Lobsters, Five-year Periods. | Average Catch per Trap, Five-year Periods. |
|---|---|---|---|---|---|---|---|---|
| 1888, . . . | 367 | 21,418 | 1,740,850 | – | 81 | – | | |
| 1889, . . . | 344 | 20,016 | 1,359,645 | 61,832 | 68 | 1: 21.90 | | |
| 1890, . . . | 379 | 19,554 | 1,612,129 | 70,909 | 82 | 1: 22.70 | | |
| 1891, . . . | 327 | 15,448 | 1,292,791 | 49,973 | 84 | 1: 25.80 | 1: 27.06 | 76.0 |
| 1892, . . . | 312 | 14,064 | 1,107,764 | 37,230 | 79 | 1: 29.75 | | |
| 1893, . . . | 371 | 17,012 | 1,149,332 | 32,741 | 62 | 1: 35.10 | | |
| 1894, . . . | 425 | 20,303 | 1,096,834 | 34,897 | 54 | 1: 31.14 | | |
| 1895, . . . | 377 | 17,205 | 956,365 | 34,343 | 56 | 1: 27.80 | | |
| 1896, . . . | 453 | 22,041 | 995,396 | 30,470 | 45 | 1: 32.60 | 1: 33.08 | 49.4 |
| 1897, . . . | 388 | 18,829 | 896,273 | 23,719 | 48 | 1: 37.70 | | |
| 1898, . . . | 340 | 16,195 | 720,413 | 19,931 | 44 | 1: 36.10 | | |
| 1899, . . . | 327 | 15,350 | 644,633 | 16,470 | 42 | 1: 39.10 | | |
| 1900, . . . | 309 | 14,086 | 646,499 | 15,638 | 46 | 1: 41.30 | | |
| 1901, . . . | 331 | 16,286 | 578,383 | 16,353 | 35 | 1: 35.30 | | |
| 1902, . . . | 410 | 20,058 | 670,245 | – | 34 | – | 1: 38.82 | 36.3 |
| 1903, . . . | 300 | 20,121 | 665,466 | – | 33 | – | | |
| 1904, . . . | 326 | 19,539 | 552,290 | 13,950 | 28 | 1: 39.60 | | |
| 1905, . . . | 287 | 13,829 | 426,471 | 9,865 | 31 | 1: 43.20 | | |
| 1906, . . . | 335 | 21,918 | 487,332 | 9,378 | 22 | 1: 52.00 | | |
| 1907, . . . | 379 | 21,342 | 1,039,886 [1] | 10,348 | 49 | 1:100.40 | 1: 84.68 | 40.2 |
| 1908, . . . | 349 | 19,294 | 1,035,123 [1] | 9,081 | 54 | 1:114.00 | | |
| 1909, . . . | 522 | 29,996 | 1,326,219 [1] | 11,656 | 45 | 1:113.80 | | |
| 1910, . . . | 390 | 26,760 | 935,356 [1] | 7,857 | 35 | 1: 68.10 | | |
| 1911, . . . | 341 | 19,773 | 822,107 [1] | 5,488 | 42 | 1:149.80 | | |
| 1912, . . . | 291 | 16,665 | 631,595 [1] | 4,744 | 38 | 1:133.10 | 1:121.16 | 37.8 |
| 1913, . . . | 254 | 13,877 | 543,129 [1] | 3,408 | 39 | 1:159.40 | | |
| 1914, . . . | 310 | 16,128 | 566,191 [1] | 5,932 | 35 | 1: 95.40 | | |
| 1915, . . . | 253 | 15,042 | 563,598 [1] | 5,050 | 37 | 1:111.60 | | |
| 1916, . . . | 244 | 13,707 | 491,940 [1] | 4,918 | 36 | 1:100.00 | | |
| 1917, . . . | 230 | 12,355 | 402,469 [1] | 4,493 | 33 | 1: 89.57 | 1: 98.96 | 38.0 |
| 1918, . . . | 323 | 18,928 | 806,796 [1] | 8,053 | 43 | 1:100.19 | | |
| 1919, . . . | 432 | 27,488 | 1,123,881 [1] | 12,026 | 41 | 1: 93.45 | | |

[1] Number of lobsters above 9 inches.

This report would not be complete without quoting the following most significant paragraphs from the last annual report of Dr. Hugh M. Smith, United States Commissioner of Fisheries, in which he says: —

Lobster hatching has practically been abandoned. The Bureau was never able to conduct it on a scale sufficiently extensive to produce any noteworthy effects on the supply, in the face of incessant fishing and a very general disregard for provisions of law affecting egg-bearing and short lobsters.

From the remnant of 8,000,000 lobster eggs carried over from the previous year's operations at the Boothbay Harbor station, 7,500,000 larval lobsters were produced and liberated in local waters in July. At the request of the Maine authorities, 2,000 stripped lobsters which the State had purchased and still owned were held at the Bureau's pound at Pemaquid

from the beginning of the fiscal year until September. When the lobsters were collected, it was discovered that a very heavy mortality had resulted, only 624 lobsters being found.

Lobster hatching in recent years was possible only under conditions that violated fundamental principles of business and biology. The Bureau was willing to continue the work year after year in the hope of bringing about a widespread observance of law by affording the fishermen a means of disposing of their berried lobsters, and by constantly keeping before the fishermen the need for saving the lobster eggs and immature lobsters. This course, however, could not be definitely continued under prevailing conditions, and Congress has now placed such limitations on the expenditure of the fish-cultural appropriation as to make it doubtful whether the lobster hatching can be legally conducted in the existing situation.

The outlook for the lobster from the standpoint of the public is distinctly gloomy in most sections, but the fishermen, as a rule, are well satisfied so long as the present outrageous prices prevail. A recent episode, doubtless typical of numerous communities, serves to indicate how difficult is the task that confronts the State officials. The lobstermen of a certain locality were called together and informed of the desire of the State to secure their support in carrying out the provisions of law for the protection of egg-bearing and short lobsters. The meeting then voted on the proposition, and more than 80 per cent of the lobstermen in the community signified their intention to continue to ignore the law.

Suffice it to say that the latter statement does not apply to Massachusetts.

In accordance with the requirement of section 5, chapter 312, General Acts of 1917, we herewith report that 970 resident and 17 non-resident lobster licenses were issued during the year 1919. The towns of issue and the names of applicants follow: —

*Barnstable.* — Resident licenses: Nelson Marchant, Henry Mortimer, Shirley D. Lovell, Edgar Bearse, Jr., Marcus Howes, E. A. Runnells, Winthrop D. Smith, Herbert A. Bacon, Jr., Chas. A. Hinckley, Chas. H. Bearse, Lazarus Cathcart, Rasmus Klinn.

*Beverly.* — Resident licenses: Warland M. Hersey, William R. Weeks, William Bouchard, Emile Bouchard, Oliver C. Hersey, Arthur Daigle, John Shaper, James E. Thibedeau, Martin A. Gustafson, Ernest S. Ostburg, Harry C. Hannable, Isaac R. Eamauss, Carl W. Foster, Edward F. Spencer, Edward R. Rowe, Stephen M. Richards.

*Bourne.* — Resident licenses: Arthur H. Gibbs, Elden M. Cunningham, Edmund B. Robinson, Joseph Maxfield Butts, Charles F. Benson.

*Boston.* — Resident licenses: H. Ross, F. Digon, W. A. Belcher, Theodore Metcalf, Antoni Vieira, August Reckast, Matthew P. Gill, Joseph P. Gill, Geatona Molett, Marim Inicynar, John M. Porte, Louis Corez, Frederick H. Baker, Frank Brengola, Carl J. F. Sanastrom, August A. Reekast, Charles H. Jennings, Manuel Vieira, A. DeGust, John Thomas, Antonio DeSouza, Norio Frank, Antonio DeNamo, Giuseppe Bracol, Paclo Merliva, John Dravellan, John Dravellan, Jr., Manuel Grace, Vincenzo Ruggieri, Amello Ruggieri, John Scimape, Francesco Autuon, Joseph Siverino, Guiseppe D. Orso, Frank D. Orso, Walter E. Wyman, Sanford McCausland, Lawrence P. DeGaust, James E. Espositi, John Bringola, F. Viera, Anthony Ferrara, Frank Rose, Anthony P. Silva, Jule Rose, James H. Wolf, Costas Zoulart, Joseph Hebert, Paul Merlino, D. Holland Treavor, Joseph P. Serrila, John Manton, Joseph V. Serrila, Albert E. Wyman, William G. Jacobs, Pasquale Giodano, A. W. Glass, Guiseppe Stimoto, Frank Mittleholzer.

*Brewster.* — Resident license: Joseph Connolly.

*Chatham.* — Resident licenses: William E. Eldridge, Jr., Willard H. Nickerson, Joseph A. Nickerson, Benjamin R. Baker, Charles G. Hamilton, M. Meads, Augustus H. Eldridge, Thomas W. Holway, Ralph W. Hunter, Joseph D. Bloomer, George C. Dunbar, Walter C. Bloomer, Seymore Patterson, Walter W. Eldridge, William H. Gould, George W. Bloomer, Jr., George W. Bloomer, Sr., Alexander Hunter, John S. Pitts, Francis L. James, Charles H. Ferguson, Jonathan Ryder, Reuben A. Tripp, Clarence W. Dunham, Elisha H. Bearse.

*Chilmark.* — Resident licenses: David T. Butler, Harry G. Reed, Jas. A. Mayhew, Benj. C. Mayhew, Roy E. Cottle, Lyman E. Cottle, Albert E. Reed, Carl E. Reed, Lester D. Mayhew, Joseph D. Tilton, Charles H. Rowland, Onslow Stuart, Ingval J. Dalen, Ernest J. Dean, Percy G. Tilton, Ralph F. Tilton, Jerry Look, Joseph Joseph, Clarence Morgan, Wm. S. Tilton, W. L. Tilton, Joseph D. Tilton, Ernest C. Mayhew, Robert N. Flanders.

*Cohasset.* — Resident licenses: Manuel E. Salvador, Antonio Gracia Formiga, Antoine S. Figueiredo, John C. Figueiredo, John Eltman, Henry B. Kimball, William B. Chalke, Joseph M. Silva, Andreas Pederson, George L. Leigh, George T. Ainslie, Arne Peterson, Matthew Brown, Patrick Grassie, John D. Golden, Carl Wellman, Joseph A. Silva, Levi Ladole, C. L. Milva, Alonzo Pearson, Alton J. Priest, W. S. Reid, Arthur C. Smith, Jr., Louis J. Figueiredo, Manuel S. Figueiredo.

*Danvers.* — Resident license: Thomas Whitesides.

*Dartmouth.* — Resident licenses: George Prieaulx, Manuel Olivera, Joseph J. Maciel, Antone Anderson, William H. Allen, John D. Snell, J. Pistana, John L. Weeks.

*Essex.* — Resident licenses: Elbridge F. Gerry, Edwin H. Burnham, John Wilson, Tyson E. Bartholomew, Harry B. Jackson, Donald R. Ferris.

*Dennis.* — Resident licenses: Benjamin Walker, George E. Hall, Isaac W. Tucker, Harry Hall, Oscar F. Gibbs, Ernest L. Tripp, Charles R. McKenzie, Fred P. Bradford, Charles D. C. Moore.

*Duxbury.* — Resident licenses: Sam Wadsworth, Geo. H. Stetson, Robert Cushman, Sumner Hancock, Frank W. Glass.

*Edgartown.* — Resident license: Rodolphus H. Morgan.

*Fairhaven.* — Resident licenses: Domingos Brown, Joseph Brown, Manuel Costa, Alexander Avilla, Peter Fontaine, C. Brown, Gaspard Souza, Frank Correia, Charles W. Cook, George J. LaPlante, John A. Silva.

*Fall River.* — Resident license: George L. Gilbert.

*Falmouth.* — Resident licenses: Alfred M. Hilton, John L. Veeder, Edward R. Robinson, Fred J. Erskine, O. R. Hilton, James F. Cook, Walter E. Nickerson, Prince M. Stuart, Wm. P. Megathlin, Antone R. Everett, Manuel G. Serpa, Arthur S. Weeks, Hans Jorgensen, Chas. G. Lorden, Horatio D. Smith, C. M. Fisher, Chas. R. Grinnell, B. K. Nickerson, Frank Roderick, Manuel Costa, Henry A. Phinney, France Minot, Robert N. Veeder, Reuben P. Hamblin, Alfred Nickerson, A. C. Swain; non-resident licenses: J. Ralph Wellman, D. F. Garland, John R. Murphy, Henry E. Wright, Hugh Montgomery.

*Gay Head.* — Resident licenses: Charles H. Ryan, Nathan A. Francis, Walter W. Manning, Francis Manning, August

Reinertson, Joseph Lang, Moses P. Cooper, Marshall Jeffers, Brazilla E. Pocknett, A. L. Rodman, L. E. Francis, George B. Cook, Benjamin J. Allaguin, Louis S. Jeffers, Leonard B. Smalley, Lonzo V. Smalley, Willard Marden; non-resident licenses: Frank B. Veeder, David P. Bosworth.

*Gloucester.* — Resident licenses: David E. Mehlman, Jr., Walter E. Marchant, David E. Mehlman, Wm. F. Enos, Jr., William F. Enos, Charles Wilson, Francis T. Shaw, Arthur Stevens, Frank Butler, Jas. E. Robinson, Fred Swanson, Manuel Viater, Jr., Herman L. Marchant, Eugene Barusso, William Foley, Alfred W. Riley, Joseph A. Goodwin, Frank Brewer, B. Franklin Saunders, Walter W. White, Edward Ashley, Geo. B. McKie, Harold B. Morgan, Ernest A. Sadler, Henry Ashley, Forrest E. Merchant, Geo. M. Wilkinson, David P. Folgelgren, Wm. J. Parks, Eugene Oliver, Augustus Oliver, Carl Pigeon, Emil M. Nelson, Jos. C. Mitchell, Manuel C. Machado, Frank Bolcome, Jesse Silva, Clarence T. Davis, Joseph M. Silva, George C. Adams, Daniel S. Webber, Antone Ferrante, Henry B. Nichols, Joseph A. Perry, B. Marchant, Henry W. Nelson, Harold E. Daniels, Henry S. Blatchford, Geo. H. Newman, Everett Gallagher, Manual Viator, John C. Spring, Fred Parsons, Daniel S. Burnham, Joseph S. Moniz, I. C. Parsons, George E. Swanson, Fred E. Kluge, John B. Knowlton, Howard Parsons, Philip W. Parsons, Ira Parsons, Albert J. Griffin, Guy R. Wolfe, Albert Parsons, Peter Knutson, George L. Jacobs, Preston J. Marchant, A. Ahonen, John C. Lycett; non-resident license: William S. Douglass.

*Gosnold.* — Resident licenses: Thomas Dowling, Alfred M. Hilton, Charles P. Mattson, Harold F. Deane, George C. King, Antonia Vieira, Victorino P. Furtado, Mike Gonsalves, Manuel Francisco Rose, Manuel Francisco Rose, Jr., Joseph Maxfield Butts, John Pashalis, John Avilla, Manuel George, John Bento, Joseph Souza, Manuel Severino, Nicholas Martin, Strat Buzza, Anastario Vulgares, John F. Connell, John Donald, Joseph Lima, Nicholas Valnos, Angelos Marrigianis, John Christ, Carl Delano Hill, George B. Taber, Howard Cornell, William R. V. Bosworth, John Karoludis, Konstantinos Karoludis, Manuel Brown, Carlton Veeder, Joseph M. Gonsalves, Russell W. Rotch, John McKay, Herbert Stetson, Robert Tilton, Isaiah Tilton,

Isaac Gregory, Walter C. Nickerson, Marion D. Mello, Clarence W. Allen, Joseph M. Sylvia, Antone Souza, Antonio Aramento, Manuel Fernedos, Manuel Roderick, Bento Gonsalves, Louis Ramos, Irwin W. Hall, Richard W. Frost, George H. Nichols, Joseph M. Seale, John Kolaczewoki, August Robiero, Alpheas P. Tilton, George Priaulx, August Souza, James C. Sarandes, John S. Sylvia, Alexander Avilla, Manuel P. Aranjo, Tharensuis Oldstad, Howard M. Smith, John F. Crowley, Joseph S. Dutia, Richard Henry Norton, Gregona Sylvia.

*Harwich.* — Resident licenses: Edwin K. Bearse, Lewis Pena.

*Hingham.* — Resident licenses: Ambrose B. Mitchell, S. V. Labree, Frank Lean, Ralph S. Place, B. A. Atwood, Henry E. Hatch, Henry Webster Mitchell, Charles A. Bridgham, E. Anderkirk, Harrison H. Gardner, Robert Crowford, M. W. Springer, Jr., Harold S. Storke, O. E. Wagner, C. H. Cobb; non-resident license: G. C. Hammons.

*Hull.* — Resident licenses: Henry W. Mitchell, Jr., Frank Spangler, Joseph E. Jones; non-resident licenses: J. Constantis, Arnold N. Allen, Daniel E. Ruse.

*Ipswich.* — Resident licenses: Charles H. Bailey, Harry E. Rutherford, Grover C. Baybry; non-resident license: Eli Perry.

*Kingston.* — Resident licenses: Peter E. Lessard, Karl R. Kreyer, Allan R. Gorham, Charles A. Maybury, Lincoln C. Bartlett, Henry S. West.

*Lynn.* — Resident license: Pasquale Sammarco.

*Manchester.* — Resident licenses: David M. Knight, Augustus Ferreira, Antone L. Silva, J. Frank Blaney, O. F. Bohaker, John S. Bohaker, Henry O. Bohaker, Nathan Greenberg, Percy Hawkes, Joseph S. Gates, John F. Babcock, Gustaf G. Helenberg, Charles A. Welch, Patrick Cleary.

*Marblehead.* — Resident licenses: Harry A. Oliver, Charles H. Smith, John W. Mace, Eben E. Snow, William H. Sweet, Wm. F. Allen, Stephen Smith, William Smith, Harry M. Frost, J. Frank Gilbert, Albert Conner, Everett Hanson, Joshua S. Withenn, William H. Tutt, Joseph Gilbert, William H. Klenk, E. O. Melzard, Washington B. Winslow, Frederick Carr Jewett, William T. Hansom, Louis N. Latourneau, L. C. Peach, Everett E. Freeto, James H. Magee, Chas. W. Coffin, Everett M. Magee, Grover C. Luscomb, W. J. R. Melzard, Clinton F.

Adams, William F. Studley, Caleb H. Foss, Charles H. Foss, Augustus K. Roundey, Samuel A. Stone, G. Stanley Frost, Charles F. Walcott, Howard S. Smith, Adelbert H. Monant, Joseph S. Phillips, John G. Gilbert, Frank A. Frost, William B. Studley, John G. Howe, Jeremiah L. Horton, Ernest Howe, Everett P. Peach.

*Marion.* — Resident licenses: Arthur E. Tripp, John E. Dowling, Harry Smith.

*Marshfield.* — Resident licenses: Asa C. Lapham, Dana B. Blackman, E. S. Publicover, Melvin F. Ewell, Lyman Sears, Henry C. Phillips, A. H. Taylor, Fred Keene, Ephraim Pierce, George Delano, Frank S. Harlow, Oscar H. Leavitt, William T. Damon, Clifford L. Goodwin, Charles H. Newton, Sr., William B. Cann, Charles E. Peterson, W. H. Hamilton, Charles R. Newton, D. C. Gray, George Graham, Robert A. Smith, Charles L. Newton, Orvis M. Savela, Jr., I. H. Bourne, Howard H. Dunbar, Gordon Atwood, Abner W. Jackson, George M. Wadsworth, Frederick L. Ford, Orvis M. Savile, Jr.

*Mattapoisett.* — Resident licenses: William H. Raymond, Freeman C. Dexter, L. S. Eldridge, Charles G. James, Walter E. Bowman; non-resident license: Henry V. Davis.

*Nahant.* — Resident licenses: Dominico Bongiarno, Bartolo Bongiarno, Gaetano Bongiarno, Angelo Mollico, Antonio Bongiarno, Peter Cirifice, Fred Felicitti, Frank Columbo, Domonic Famolari, Mariano Pustareno, Warren P. Taylor, W. A. Smith, Antonio Lapez, Frank A. Gove, Paolo Sciaba, Giatano Lopis, Charles Roberts, Tony Famolari, Anthony Martinco, Augusto Felicitti, John M. Taylor, Edward G. Cook.

*Nantucket.* — Resident licenses: Walter Jewett, Harry E. Dunham, Wesley B. Lewis, Earl A. Mayo, James A. Backus, Jr., William M. Brown, Amos E. Arey, Harry C. Studley, Erastus Chapel, Charles C. Eldridge, Jr., Edward F. Trevor.

*New Bedford.* — Resident licenses: George A. Faullenes, Antone A. Sylvia, Antonio B. Mello, Joseph Fereira, Joseph Dutra, Antone Nunes, Marinao Tavares, John Barao, Victorino Pereira, Manuel E. Sylvia, Augusto Souza, Anastasa Koenig, August Vieira, Jose Medeiris, Edward A. Silva, Justino Pereira, Edward A. Sylvia, Jr., Jacintho Rose, John Moniz, Bartholomew A. Sylvia, Alfred C. Post, Calix Breau, John Kolsczewski,

Francisco Moniz, August Riberro, Gregorio Silva, Ben Perry, John Gillis.

*Newburyport.* — Resident license: Geo. R. Littlefield.

*Oak Bluffs.* — Resident licenses: Lewis Bartlett, Harold H. Folten.

*Orleans.* — Resident licenses: George Cummings, David L. Young, Daniel B. Gould, Howard N. Snow, Ralph W. Snow, Lawrence T. M. Hopkins, Frank K. Freeman, Willis S. Gould, Alvin B. Gould, Clarence Robbins, William W. Wixon, Fred Thompson, John D. Taylor, Warren R. Bennett, Emile C. Frazmann, Elsie W. Tenney.

*Plymouth.* — Resident licenses: Thomas C. Longstrett, Wallace J. Nightingale, J. Russell Harlow, Charles M. Sampson, Ralph B. Holmes, Charles A. Dixon, A. H. Dixon, Herbert J. Caswell, George L. Binney, Henry Quinchon, L. B. Briggs, Jr., Enrico Trentim, John A. Brierly, Fred Wood, David H. Briggs, L. B. Briggs, Edwin H. Bartlett, Frank Carboni, Antonio Brigide, Frank R. Peterson, Augustus B. Rogers, Edward L. Dixon, Frank Simmons, Edwin F. Hayward, H. A. Slader, Marino Cannice, Samuel B. Benson, Eugene H. Arnold, Albert A. Nightingale, Daniel Town, Herbert A. Ryder, Robert Richardson, Ernest Johns, Charles W. Raymond, Wesley T. Derrick, Henry L. Perry, Patrick I. Glynn, Leone Mosce, George A. Ellis, Albert W. Boutin, Albert D'Entremont, Willard V. Boardman, Gaetano Manze, Albert F. Pierce, J. Albert Russell, Frank P. Brooks, Percy H. Marsh, P. H. Whiting, Albert D. Whiter, John Thompson, Otto M. Schulz, George N. Wood, William Husland, James E. Burke, Joseph Casson, Herbert F. Drew, James S. A. Valler, Anthony Garuti, Samuel B. Blackmer, D. P. Ward, Joseph A. Sherman, A. B. Butler, Casmero Monteira, Granville W. Peitt, Charles H. Pierce, Harry N. Spencer, Richard Sherburne, Paul F. O'Brien, George V. Hildreth, Levi Thurston, Roderick L. Sherman, Charles H. Davis, H. D. Cleveland, Harry Boutin, Harry L. Sampson, P. Whiting, Burton W. Smith, William F. Farley, Herbert B. Eddy, Ellsworth B. Wright, Harold R. Hadaway, Charles T. Massey, Nathan W. Pratt, H. H. Archibald, Richard Collins, Jr., John P. Richardson, John M. Watson, George M. Sampson, Charles S. Courtenay, Roger C. Holden, Alvin E.

Nightingale, William L. Russell, Jr., Patrick Russo; non-resident licenses: T. C. Longstretch, John Platt, Jr., John J. Stickney.

*Provincetown.* — Resident licenses: Joseph Brown, Llewelyn Rogers, John W. Savage, Manuel S. Packet, Joshua T. Nickerson, Reginald G. Phillip, Jos. E. Brown, Jos. A. Morris, Chas. W. Schumann, Jr., Robert Newcomb, John Enos, Alvin E. Newcomb, Jos. S. Avila, John T. Avila.

*Quincy.* — Resident licenses: John I. Myers, Guy F. Hardy, Demetrios Varenopolos, John I. Bennett, Manley Young, George E. Muirhead, Charles W. Tyler, George A. Parmenter, Sylvester Doricette, Frank B. Blanchard, J. Lester Boyd.

*Revere.* — Resident licenses: Charles W. Smith, Joseph Gasper, Eugene J. Love, Carl Michelson; non-resident license: William Rogers.

*Rockport.* — Resident licenses: John M. Silva, Willis A. Wheeler, Arthur F. Rich, Charles M. Currier, Ernest H. Whittaker, George T. Gustavus, Stephen R. Orr, Carl J. Green, Harold C. Clifford, John E. H. Cook, George E. Wendell, John F. Lawson, Everett D. Rowe, Alfred F. Blatchford, Chester W. Gott, Arthur Norwood, William E. Bennett, Franklin W. Babson, Samuel D. Thurston, Carl E. Nelson, W. Russell Norwood, William E. Norwood, Herman Nelson, John A. Nelson, Hans Palmquest, Andrew Swanson, John Bowman, Carl J. Wredenberg, Fred A. Poole, Addison H. Woodbury, John Swanson, Frank P. Gamage, Charles C. Upham, Ernest G. Nelson, Arthur W. Rich, Martin Bowman, John J. Stillman, Albert F. Stillman, Fred Hobbs, Arthur F. Rich, Howard S. Bates, Charles Boynton Morse, William W. Gray, Harry W. Gray, Edward Hanson, Walter Francis Hawley, Arthur R. Woodbury, James E. Allen, Harvey A. Malone, Stephen R. Orr, Herbert R. Rich, John Breen, Carl F. Norberg, Andrew Silva, Joseph Bragar, Ernest Rich, John R. Allen, William A. Enos, Ernest H. Whitaker, Alfred Swanson, John Enos, Wm. Everett Clarke, Frank S. Hill, Charles W. Marshall.

*Salem.* — Resident licenses: John A. Dunn, George W. Dunn, Charles S. Brown, Charles G. Begwood, Daniel C. Fitz, Anthony J. Gonet, J. Herbert Merrow, Charles P. R. Fellows.

*Salisbury.* — Resident license: Willard W. Fowler.

*Sandwich.* — Resident licenses: Arthur Buckley, Arthur Hamblin, Edward P. McArdle, Robert P. Nockel, Henry P. Swansey, William H. Parks & Co., Eugene W. Hayes, Leonard S. Rankin, Manuel V. Silva, Patrick McKeon.

*Scituate.* — Resident licenses: Danforth P. Sylvester, Fred Bergman, William Stanley, Charles B. Dillard, David F. Fraser, Frank H. Barry, William Driscoll, Charles P. Curran, Dennis F. Quinn, Kenneth Worck, James J. Barry, Stacy W. Moore, James L. McCarthy, Margaret Christine Doherty, John Hee, Frank H. Young, Maxwell Jenkins, Thomas L. Daigon, Richard Whitely, James J. O'Hern, Frank H. Young, C. Bertram Tilden, Charles DeCost, C. Harry Driscoll, John Francis Cushman, Albert E. Reed, Fred A. Conroy, George F. Daigon, R. Frank Hall, Samuel F. Smith, Thomas S. Turner, Maxwell Jenkins, John F. Driscoll, John Stonefield, Moses H. Fellows, Dennis F. Quinn, John Flynn, Richard Graham, Eugene Pratt, James W. Welch, Fred G. McCarthy, David F. Fraser, William Driscoll, Richard Gargan, Oscar Anderson, William J. Flynn, James H. McCarthy, John F. Fallon, Martin F. Quinn, Seth Vinal, Henry P. Tobin, Atherton L. Baker, Martin Curran, Jr., Joseph Flynn, James L. McCarthy, Bartley Curran, Paul R. Gaunett, Samuel Cummings, Gilbert J. Patterson, Oliver Bergman, Leonard H. Rhoades, John Hee, Chester F. Spear, Thomas H. Harris, William P. Jenkins, Charles P. Curran, Frank H. Barry, Thomas L. Dwyer, George L. Barbour, Albert F. Lewis, Francis S. Cutting, William E. Pray, Christopher O'Neil, Sumner E. Parker, R. E. Pray, Edward Ward, Thomas H. O'Neil, Christopher O'Neil, Leon Hatch, Louis H. Madore, Edwin L. Bates, Fletcher P. Bouton.

*Swampscott.* — Resident licenses: Ernest B. Thing, Henry E. Douglass, Alfred L. William Stover, Charles L. Stover, Walter M. Boyden, Raymond E. Bond, Harry M. Goodwin, Max P. Codwise, Charles M. Cahoon, Leonard P. Lewis, Fred Blanchard, Charles N. Darcy, Emeline W. Parker, Henry E. Acher, Alfred G. Watts, Alfred W. Watts, Chester W. Cook.

*Tisbury.* — Resident licenses: John Mason, Manuel K. Rose, Norman T. Benson, J. R. Cleveland, Fred C. Peakes, Paul D. Gibbs, Louis E. Swift, Fred M. Chase, Ed. Cleveland.

*Truro.* — Resident licenses: Manuel C. Francis, N. O. Atwood, John Silva, Joseph W. Gray, Everett W. Lombard.

*Wareham.* — Resident licenses: George H. Halett, Manuel V. Galdino, Caesar Lopes, Nelson Huckins, Louis Dias, John A. Harrisson, Walter Ela, M.D.

*Wellfleet.* — Resident licenses: Frank E. Chamberlain, J. H. Whitcomb, E. M. Rogers.

*Westport.* — Resident licenses: Henry P. P. Brayton, Joseph H. Sowle, John R. Fish, Jr., Harry G. Sowle, Charles D. Macomber, John Wilbur, Jr., John H. Wilbur, Raymond A. Palmer, John Jenkinson, Joseph S. Field, Frank D. Grinnell, Henry S. Palmer, A. S. Nickerson, Lester A. Mosher, Thomas E. Pettey, John H. Pettey, Herbert E. Fish, John R. Fish, William S. Head, Arthur R. Cornell, Frank G. Macomber, Herman A. Hart, Lester A. Bowman, J. Lyman Austin, Isaac B. Pettey, Ralph W. Wood, Lester A. Mosher, Clinton G. Albert, Frank W. Jennings.

*Weymouth.* — Resident licenses: Frank J. Gain, Alfred F. Turner, William P. Kent, Chas. J. Rogers, M. F. Turner.

*Winthrop.* — Resident licenses: Kenneth S. Johnson, George F. McDuffee, Fred H. Crowley.

*Yarmouth.* — Resident licenses: Elmer N. Newell, Nemiah Newell, William H. Newell, U. H. Goodwin.

## Shad.

Owing to the inability to procure eggs, no further action has been taken in the propagation of shad.

## Alewives.

We have been at work for several years upon the problem of developing the alewife fishery, and as a result have prepared a report embodying the results of our studies, which is now ready for publication.

### *Commercial Importance of the Fishery.*

The alewife or branch herring (*Pomolobus pseudoharengus*) is the most abundant food fish inhabiting the rivers of the Atlantic coast, from Maine to Florida, and with the disappearance of the shad has become commercially the most valuable anadromous

fish in Massachusetts. Ever since the landing of the Pilgrims, when the alewife provided the most readily available source of food for the early inhabitants of New England, it has been closely related to the prosperity of the shore towns, where it has always been held as a public asset.

The alewife is of value as food, as bait and as a food supply for other fish. Either fresh or cured, the alewife forms an excellent and inexpensive article of diet. Because of its abundance and comparative cheapness, it is satisfactory as a bait supply. However, of greater importance is the attraction it forms for large schools of pollock, bluefish, striped bass, squeteague and other food fishes, which come to our shores to prey upon the young alewives when they descend the coastal streams. The simultaneous decline of the alewife and shore fisheries suggests that there is a direct relation between the two.

*Survey.*

In our original survey in 1913 we examined the natural condition of the streams and spawning grounds, especially as regards obstructions and pollution, obtained the history of the fishery from town records and by interviewing men acquainted with the business, and collected statistics of the production at that time. During the past year a second survey was made, and not only were all statistics brought up to date, but all changing natural conditions which would influence the fishery were recorded. The principal differences noted were the great increase in the price of alewives, the increasing value of certain streams properly cared for, and the decrease in other streams improperly handled, although on the whole there was little difference in the total catch.

On Marthas Vineyard at Edgartown Great Pond the run of alewives this year was earlier than usual, but the yield was subnormal, while at Tisbury Great Pond it was normal. It was also earlier at Weymouth and Falmouth, and later at Plymouth and Kingston, while the other locations were approximately normal.

At East Taunton the early run was poor, but later in the season the number of fish passing through the fishway was above normal.

*Remedial Measures.*

As briefly outlined, our biological investigation of the Massachusetts alewife fishery has shown its present condition, the causes contributing to its decline, and has brought out certain points in the life history and habits of the alewife which furnish a basis for establishing cultural methods.

The requisite steps in this reconstruction work are as follows: —

1. An unobstructed and uncontaminated passageway from salt water to the spawning grounds.

2. Artificial restocking of depleted streams, and the creation of new fisheries in favorable localities.

3. Adequate and efficient methods of regulating the fishery.

In the spring of 1919 the work which had been suspended during the war was resumed, and the important problem of obtaining a clear passageway for the fish to the spawning grounds, as a preliminary requisite for stocking, was first taken up. At the same time preliminary cultural work and artificial hatching of alewife eggs, has guaranteed beyond a reasonable doubt the future success of restocking the depleted streams.

1. *Fishways.* — Considered elsewhere in this report, under the heading of "Fishways." At Brightman's Pond, Westport, the alewives were carried over the dam owing to the dilapidated condition of the fishway.

2. *Stocking Methods.* — All stocking methods are based upon the "Parent Stream Theory," which presupposes that the young alewives return as mature fish to the same stream where they were hatched. Depleted streams can be restored, and new fisheries created by stocking, through the introduction of young alewives into the headwaters, which may be accomplished in two ways, — transplanting mature, ripe alewives to the spawning ponds, and planting artificially hatched fry.

The yield of certain exhausted streams has been greatly increased by transplanting into their headwaters spawning alewives from productive streams. It is sure, practical, and at the present time the only certain step for restocking depleted streams. It possesses the great objection of expense in catching and transporting the adult fish. Possibly small alewives could

be seined in the late summer and similarly transported at a less cost.

The ideal method of restocking would be to plant artificially hatched alewives. Sufficient preliminary work has been carried out along this line to indicate that commercial hatching is feasible. The principal obstacle is obtaining ripe fish for stripping. It is impracticable to obtain the fish in their journey up stream, since the ratio of males to females is large, and practically all the eggs are "green" at this time. Seining the fish on the spawning grounds seems the logical method of approach, unless the alewives can be held in pockets on their journey up stream until the eggs ripen. The ratio of male and female necessitates handling large numbers of superfluous males, as well as many unripe females. However, a sufficient quantity of eggs may be secured for the work with labor and patience.

On June 12 and June 25 forty-eight ounces of good eggs were taken from a few ripe fish among 800 alewives seined in Great Herring Pond, Bournedale, after various unsuccessful attempts had been made to obtain ripe fish by holding the alewives in pens. The eggs were about the same size as those of the white perch, measuring 1,600,000 to the quart. The fish are stripped by the usual method. After fertilization, owing to their adherent nature, the eggs will mass together, but this may be obviated by constant stirring and by changing the water in which they are every five minutes until they harden. Hatching took place at 67° to 72° F. in forty-eight to ninety-six hours in open top MacDonald hatching jars at the Sandwich Hatchery. The eggs at first adhere to each other, but later they separate, becoming firm, hard and a light coffee color. The fry, which have the appearance of fine, transparent threads attached to a relatively large yolk sac, can be held only for a short time in tanks before planting. The fry were planted in Great Pond, East Sandwich.

The advantage of artificial hatching over natural spawning is the protection of the egg from the inroads of suckers, white and yellow perch, which frequent the spawning grounds. For protection from these fish the fry should be liberated over a wide territory.

In spite of the great difficulty in obtaining the ripe fish, the

artificial hatching of alewives is a practical procedure, but the beneficial effects of planting the fry cannot be demonstrated for several years. Results were so encouraging that extensive cultural work is planned for the coming year.

## Shellfish.

### *Clams.*

The exceedingly mild and open winter of 1918–19 proved a great boon to the clamming industry, since it enabled the clammers to work nearly every day, thus increasing total production and individual incomes. With little ice there was slight destruction of the small "seed" clams. An extremely large 1918 set was reported along the whole shore, especially in Essex River, at Black Rock and Castleneck; in North River and Green Harbor, near Captain's Hill, Duxbury, and Wind Flat, Kingston; in Barnstable Harbor; in Wellfleet Harbor; at Buck's Creek, Chatham; Mattapoisett; Padanaram; at Brayton Neck, Somerset; in Mount Hope Bay; and in Cole's River, Swansea. Protected by the open winter, clamming should be especially good for the next two years. The hard winter of 1917–18 served to increase the natural supply by preventing overdigging, and thus made clamming more remunerative during the past season. However, in spite of the open winter and natural abundance, owing to war activities there were fewer men engaged in the business.

Prices were good, clammers receiving about 25 cents more a bushel than in 1918. Clams sold for from $1 to $2 per bushel, according to the locality, quality and time of year. The average was about $1.50, most sales bringing between $1.25 and $1.75 per bushel.

A new and interesting feature was the use of the auto truck in marketing and delivering clams in Essex County.

### *Oysters.*

The returns from the oyster industry approximated the production in previous years. At Wellfleet there was a smaller yield than usual, 7,000 barrels having been shipped. The in-

creased price for the product ranged from $6 to $8 per barrel. Practically no set was obtained in any waters of the Commonwealth.

*Quahaugs.*

The mild winter was particularly favorable to the quahaug fishery, as it allowed practically continuous fishing. Although the production was normal, the higher prices made the business especially attractive. Prices ranged as follows: littlenecks, $12 to $14 per barrel; "sharps," $9 to $10; and "blunts," $5 to $6. On Cape Cod about 12,000 barrels were shipped, the usual number of men being engaged in the fishery, and there were good sets of seed quahaugs. In the off-shore beds of Nantucket quahaugs were still plentiful, although not in the abundance of former years following the discovery of this productive territory. Here, for the first time, fishing was conducted all winter, by fewer men, at the high price of $7 to $12 per barrel for the large quahaugs, notwithstanding increased demand and prevalent soaring prices.

In Buzzards Bay there was a slight falling off in production. Very few men followed the fishing, owing to the shortage of labor and the high prices paid in other lines of work.

The report of the board of shellfish commissioners for the city of New Bedford and the town of Fairhaven, under chapter 411, Acts of 1911, shows that there were issued 109 first-class licenses, 3 second-class, 3 third-class, and 44 bait permits, bringing in a total receipt of $1,448 for the year ending May 31, 1919, during which time expenditures for the enforcement of the law totaled $2,184. Seven arrests were made by inspectors and $80 in fines collected.

*Scallops.*

A great scarcity of adult scallops marked the 1918–19 season. Few, if any, could be found in Buzzards Bay and along Cape Cod, while the Nantucket catch was light. Naturally the demand was excellent, prices averaging about $4 per gallon, and at times reaching as high as $5. Undoubtedly this scarcity was brought about by the severe winter of 1917–18, with its resultant destruction of the "seed" scallops. Except at Nantucket fewer men were engaged in the business.

The open winter of 1918–19 permitted continuous fishing when scallops were found, and was especially beneficial in conserving the enormous and remarkable set of seed scallops which took place in Buzzards Bay, on the south side of Cape Cod, and at the Nantucket beds. Few were destroyed, and the output for the 1919–20 season appears to be most propitious.

With regard to the scallop, Walter K. Perry, warden for the industry in the town of Wareham, had the following to say in his report to the department: —

> Very few people realize what the scallop industry means to Massachusetts. The New Bedford Fish Company, which handles about 80 per cent of the scallops caught in Marion, have paid about $3,500 a week from October 1 to the present time. Mattapoisett and Bourne have each about the same number of boats as Marion. Wareham has about twice as many as Marion. The season at Fairhaven and New Bedford was very short. There are about 175 boats and 300 men engaged in this fishing. Add to this the men and women who open them up, and you have a total of at least 500 people who are making their living from the scallop fishery. I feel safe in saying that over $200,000 will be divided among the fishermen in these four towns by January 1.

### *Mussels.*

The edible mussel is but little used for food in Massachusetts, although quantities are used for bait, in striking contrast to European countries, where it is highly esteemed as an article of food. About 150 barrels are consumed in Boston per year, entirely among the foreign population.

On Cape Cod mussels are taken only for bait. The set was reported as unusually good during 1919.

Respectfully submitted,

WILLIAM C. ADAMS.
GEORGE H. GRAHAM.
ARTHUR L. MILLETT.

# APPENDIX

## STATISTICS.

*Returns from the Shore Net and Pound Fisheries for the Year 1919.*

["L" indicates that the person engaged also in lobster fishing, and the figures are given in the table entitled "Returns from the Lobster Fisheries, 1919."]

| Proprietor. | Town. | Number of Men. | Number of Boats. | Value. | Number of Pounds. | Value. | Number of Nets. | Value. |
|---|---|---|---|---|---|---|---|---|
| Ensign C. Jerauld, | Barnstable, | 10 | 6 | | | | | |
| Shirley D. Lovell, | Barnstable, | 3 | 6 | $7,495 00 | 3 | $5,300 00 | 119 | $2,750 00 |
| Nelson Marchant, | Barnstable, | 1 | 3 | | | | | |
| Ansel Taylor, | Barnstable, | 2 | 1 | | | | | |
| James E. Eldridge, | Brewster, | 1 | 1 | | | | | |
| Gilbert E. Ellis, | Brewster, | 3 | 4 | 620 00 | 8 | 3,700 00 | 2 | 50 00 |
| Arthur S. Hall, | Brewster, | 6 | 4 | | | | | |
| George W. Bloomer and George W. Bloomer, Jr., | Chatham, | 2 | 1 | | | | | |
| George C. Dunbar, | Chatham, | 1 | 3 | | | | | |
| Roscoe H. Gould, | Chatham, | 4 | 3 | 3,185 00 | 2 | 2,500 00 | 101 | 1,410 00 |
| Thomas W. Holway, | Chatham, | 1 | 2 | | | | | |
| Seymour Patterson, | Chatham, | 1 | 1 | | | | | |
| David Butler, | Chilmark, | L | L | | | | | |
| E. C. Flanders & Co., | Chilmark, | 3 | 4 | 1,200 00 | 4 | 2,300 00 | 6 | 49 50 |
| Welcome L. Tilton, | Chilmark, | 3 | 5 | | | | | |
| Daniel W. West, | Chilmark, | 3 | 5 | | | | | |
| Alonzo Ellis, | Dennis, | 4 | 3 | | | | | |
| George E. Hall, | Dennis, | 1 | 1 | 245 00 | 1 | 100 00 | 34 | 410 00 |
| Harry Hall, | Dennis, | L | L | | | | | |
| Benjamin Walker, | Dennis, | 1 | 2 | | | | | |
| Harry E. Hunt, | Duxbury, | 3 | 3 | 840 00 | 2 | 4,000 00 | 1 | 3 00 |

*Returns from the Shore Net and Pound Fisheries for the Year 1919* — Concluded.

| Proprietor. | Town. | Number of Men. | Number of Boats. | Value. | Number of Pounds. | Value. | Number of Nets. | Value. |
|---|---|---|---|---|---|---|---|---|
| Domingo Brown, | Fairhaven, | L | L | $1,430 00 | 6 | $3,000 00 | - | - |
| John Brown, | Fairhaven, | 1 | - | | | | | |
| Charles W. Cook, | Fairhaven, | 1 | 2 | | | | | |
| Charles D. Cowan, | Fairhaven, | 1 | 2 | | | | | |
| Frederick Pease, | Fairhaven, | 1 | 4 | | | | | |
| Charles E. Westgate, | Fairhaven, | 2 | 2 | | | | | |
| H. Nelson Wilbur, | Fairhaven, | 1 | 4 | | | | | |
| George M. Gray, | Falmouth, | 5 | 6 | 2,650 00 | 2 | 1,800 00 | - | - |
| Reuben Hamblin, | Falmouth, | L | L | | | | | |
| Marine Biological Laboratory, | Falmouth, | 5 | 6 | | | | | |
| L. L. Vanderhoop, | Gay Head, | 4 | 3 | 175 00 | 1 | 700 00 | - | - |
| Frank C. Hodgkins, | Gloucester, | 2 | 2 | 2,546 00 | - | - | 1 | $128 00 |
| Henry W. Nelson, | Gloucester, | 2 | 2 | | | | | |
| Charles F. Tarr, | Gloucester, | 1 | 4 | | | | | |
| George C. King, | Gosnold, | 1 | 6 | 570 00 | 2 | 2,000 00 | - | - |
| Edward W. Heath, | Manchester, | 3 | 5 | 1,330 00 | 1 | 3,000 00 | 2 | 40 00 |
| Arthur J. Barrett & Co., | Nantucket, | 10 | 12 | 4,050 00 | 3 | 30 00 | 106 | 1,030 00 |
| Manuel F. Rose and Manuel F. Rose, Jr., | New Bedford, | L | L | L | - | - | 1 | 150 00 |
| C. A. Caswell & Co., | Newburyport, | 2 | 2 | 60 00 | - | - | 2 | 150 00 |
| George A. Finney, | Plymouth, | 2 | 5 | 200 00 | 1 | 600 00 | - | - |
| R. L. Sherman, | Plymouth, | L | L | | | | | |
| A. L. Daggett, | Provincetown, | 7 | 5 | 11,718 00 | 2 | 1,000 00 | 291 | 5,600 00 |
| Manuel James, | Provincetown, | 2 | 1 | | | | | |
| John Johnson, | Provincetown, | 3 | 1 | | | | | |
| Levi A. Kelley, | Provincetown, | 1 | 1 | | | | | |
| William B. Lewis, | Provincetown, | 3 | 1 | | | | | |
| Alfred A. Mayo, | Provincetown, | 1 | 2 | | | | | |
| H. L. Mayo, | Provincetown, | 2 | 3 | | | | | |
| Frank I. Sears, | Provincetown, | 3 | 2 | | | | | |
| Manuel P. Vena, | Provincetown, | 1 | 1 | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| A. W. Goff, | Raynham, | 8 | 1 | 425 00 | - | - | 5 | 500 00 |
| Edwin Williams, | Raynham, | 14 | 4 | | | | | |
| George W. Dunn, | Salem, | L | L | 85 00 | - | - | 10 | 50 00 |
| Anthony J. Gonet, | Salem, | 1 | 2 | | | | | |
| E. W. Haines, | Sandwich, | 1 | 4 | 375 00 | - | - | - | 156 00 |
| W. J. Flynn, | Scituate, | L | L | - | - | - | 3 | 75 00 |
| R. Frank Hall, | Scituate, | L | L | | | | | |
| Martin J. Quinn, | Scituate, | L | L | | | | | |
| Charles Gardner, | Somerset, | 1 | 2 | 40 00 | - | - | 2 | 100 00 |
| C. E. F. Benson, | Tisbury, | 1 | 1 | 850 00 | 10 | 5,040 00 | - | - |
| Norman Gifford Benson, | Tisbury, | 2 | 4 | | | | | |
| Fred S. Daggett, | Tisbury, | 1 | - | | | | | |
| Otis B. Luce, | Tisbury, | 2 | 5 | | | | | |
| H. Nelson Luce, | Tisbury, | L | L | | | | | |
| Lester A. Bowman, | Westport, | L | L | L | - | - | 3 | 101 00 |
| Frank D. Grinnell, | Westport, | L | L | | | | | |
| Edgar M. Baker, | Yarmouth, | 2 | 2 | L | - | - | 29 | 325 00 |
| Elmer Newell, | Yarmouth, | L | L | | | | | |
| Totals, | | 153 | 167 | $40,089 00 | 48 | $35,070 00 | 718 | $13,077 50 |

*Number of Pounds of Fish taken*

| Town. | Alewives. | Bluefish. | Flounders. | Mackerel. | Menhaden. | Pollock. | Cod. | Scup. |
|---|---|---|---|---|---|---|---|---|
| Barnstable, . . . . | - | - | 57,800 | 126,905 | - | 1,500 | 13,800 | - |
| Beverly, . . . . | - | - | - | - | - | - | - | - |
| Boston, . . . . | - | - | - | - | - | - | - | - |
| Bourne, . . . . | - | - | - | - | - | - | - | - |
| Brewster, . . . . | 40,798 | 115 | 781 | 48,354 | - | - | - | - |
| Chatham, . . . . | 1,000 | - | 23,670 | 110,924 | - | - | 12,300 | - |
| Chilmark, . . . . | 16,097 | - | 3,662 | 7,647 | - | 66 | 25 | 6,905 |
| Cohasset, . . . . | - | - | - | - | - | - | - | - |
| Dennis, . . . . | - | 177 | 610 | 8,226 | - | - | - | - |
| Duxbury, . . . . | - | - | - | 10,200 | - | - | - | - |
| Fairhaven, . . . . | 47,819 | - | 10,964 | 21,521 | - | - | - | 12 |
| Falmouth, . . . . | 290 | - | 166 | 2,049 | 1,903 | 66 | - | 552 |
| Gay Head, . . . . | - | - | - | 1,500 | - | - | - | 2,000 |
| Gloucester, . . . . | 8,950 | - | 89,751 | 68,615 | - | 50,600 | 41,000 | - |
| Gosnold, . . . . | 100 | - | 15 | 68 | - | - | - | 20,234 |
| Kingston, . . . . | - | - | - | - | - | - | - | - |
| Lanesville, . . . . | - | - | - | - | - | - | - | - |
| Manchester, . . . . | 465 | - | - | 5,338 | - | - | 28,707 | - |
| Manomet, . . . . | - | - | - | - | - | - | - | - |
| Marblehead, . . . . | - | - | - | - | - | - | - | - |
| Marshfield, . . . . | - | - | - | - | - | - | - | - |
| Nahant, . . . . | - | - | - | - | - | - | - | - |
| Nantucket, . . . . | 34,000 | - | 4,210 | 63,700 | - | 900 | - | 2,450 |
| New Bedford, . . . | - | - | - | 1,950 | - | - | - | - |
| Newburyport, . . . | - | - | - | - | - | - | - | - |
| Orleans, . . . . | - | - | - | - | - | - | - | - |
| Plymouth, . . . . | - | - | - | 6,687 | - | - | - | - |
| Provincetown, . . . | 35,000 | - | 346,400 | 280,145 | - | - | 2,800 | - |
| Raynham, . . . . | 246,734 | - | - | - | - | - | - | - |
| Rockport, . . . . | - | - | - | - | - | - | - | - |
| Salem, . . . . | - | - | 2,781 | - | - | - | 10,938 | - |
| Salisbury, . . . . | - | - | - | - | - | - | - | - |
| Sandwich, . . . . | - | - | - | 2,868 | - | 20 | 1,381 | - |
| Scituate, . . . . | - | - | - | - | - | - | 700 | - |

*in Pounds, Nets, Traps, etc., 1919.*

| Haddock. | Sea Herring. | Shad. | Squeteague. | Hake. | Squid. | Tautaug. | Other Edible or Bait Species. | Lobsters. | Total Weight. | Total Value. |
|---|---|---|---|---|---|---|---|---|---|---|
| - | 27,650 | 50 | - | - | 37,375 | 200 | 320,874 | 3,282 | 589,436 | $26,432 85 |
| - | - | - | - | - | - | - | - | 40,332 | 40,332 | 9,083 17 |
| - | - | - | - | - | - | - | - | 4,872 | 4,872 | 1,943 36 |
| - | - | - | - | - | - | - | - | 19,125 | 19,125 | 4,346 56 |
| - | 114,881 | 92 | - | - | 8,090 | 352 | 18,078 | - | 231,541 | 11,163 15 |
| 1,200 | 116,200 | 5,300 | - | - | 52,100 | - | 28,945 | 16,737 | 368,376 | 22,768 38 |
| - | - | - | 629 | - | - | - | 26,650 | 180,812 | 242,493 | 32,444 82 |
| - | - | - | - | - | - | - | - | 8,961 | 8,961 | 9,303 54 |
| - | - | - | - | - | 9,000 | 723 | 6,647 | 9,072 | 34,455 | 4,078 29 |
| - | 338,200 | - | - | - | - | - | - | 1,241 | 349,641 | 4,668 15 |
| - | 26,915 | 15 | 270 | 83 | 116,884 | 10,585 | 46,566 | 30,956 | 312,590 | 12,437 26 |
| 2,631 | 600 | - | 243 | 395 | 5,801 | 20 | 19,007 | 33,651 | 67,374 | 6,631 65 |
| - | - | - | - | - | - | - | - | 49,892 | 53,392 | 8,228 30 |
| - | 46,600 | - | - | - | - | - | 55,485 | 98,372 | 459,373 | 31,060 13 |
| - | - | - | - | 6 | - | - | 3,002 | 186,941 | 210,366 | 29,125 26 |
| - | - | - | - | - | - | - | - | 3,441 | 3,441 | 819 00 |
| - | - | - | - | - | - | - | - | 975 | 975 | 208 75 |
| - | 194,684 | - | - | - | 2,496 | - | 151,136 | 2,381 | 385,207 | 4,968 14 |
| - | - | - | - | - | - | - | - | 1,070 | 1,070 | 77 75 |
| - | - | - | - | - | - | - | - | 124,869 | 124,869 | 27,534 31 |
| - | - | - | - | - | - | - | 6,800 | 62,870 | 69,670 | 11,615 17 |
| - | - | - | - | - | - | - | - | 5,670 | 5,670 | 770 68 |
| - | 8,100 | 12,800 | - | - | 3,350 | - | 115,000 | 3,612 | 248,122 | 15,764 00 |
| - | - | - | - | - | - | - | - | 205,226 | 207,176 | 34,476 60 |
| - | - | - | - | - | - | - | 14,524 | - | 14,524 | 607 27 |
| - | - | - | - | - | - | - | - | 1,050 | 1,050 | 425 00 |
| - | 68,400 | - | - | - | 1,800 | - | 8,240 | 177,557 | 262,684 | 38,106 42 |
| - | 700 | - | - | - | 47,200 | - | 38,125 | 194 | 750,564 | 58,420 10 |
| - | - | 298 | - | - | - | - | - | - | 247,032 | 2,767 60 |
| - | - | - | - | - | - | - | - | 107,498 | 107,498 | 25,648 78 |
| - | - | - | - | - | - | - | - | 35,775 | 49,494 | 10,758 01 |
| - | - | - | - | - | - | - | - | 2,966 | 2,966 | 578 65 |
| - | 3,729 | 3 | - | - | 550 | 249 | 41,299 | 10,173 | 60,272 | 3,955 45 |
| - | 4,000 | - | - | 800 | - | - | 800,800 | 164,562 | 970,862 | 30,736 58 |

*Number of Pounds of Fish taken in*

| Town. | Alewives. | Bluefish. | Flounders. | Mackerel. | Menhaden. | Pollock. | Cod. | Scup. |
|---|---|---|---|---|---|---|---|---|
| Somerset, . . . | – | – | – | – | – | – | – | – |
| Swampscott, . . . | – | – | – | – | – | – | – | – |
| Tisbury, . . . . | 23,648 | 121 | 8,331 | 19,569 | – | 2,285 | 1,341 | 17,096 |
| Westport, . . . | 13,000 | – | – | – | – | – | – | – |
| Weymouth, . . . | – | – | – | – | – | – | – | – |
| Yarmouth, . . . | – | – | – | – | – | – | – | – |
| Totals, . . . | 467,901 | 413 | 549,141 | 786,266 | 1,903 | 55,437 | 112,992 | 49,249 |

*Pounds, Nets, Traps, etc., 1919* — Concluded.

| Haddock. | Sea Herring. | Shad. | Squeteague. | Hake. | Squid. | Tautaug. | Other Edible or Bait Species. | Lobsters. | Total Weight. | Total Value. |
|---|---|---|---|---|---|---|---|---|---|---|
| - | - | - | - | - | - | - | 1,300 | - | 1,300 | $72 00 |
| - | - | - | - | - | - | - | - | 1,473 | 1,473 | 349 00 |
| 554 | 25 | 337 | 2,484 | - | 6,999 | 182 | 50,823 | 5,790 | 139,585 | 9,571 99 |
| - | - | - | - | - | - | - | - | 69,119 | 82,119 | 10,234 00 |
| - | - | - | - | - | - | - | - | 12,456 | 12,456 | 4,931 51 |
| - | - | - | - | - | - | - | 4,970 | 2,856 | 7,826 | 5,236 37 |
| 4,385 | 950,684 | 18,895 | 3,626 | 1,284 | 291,645 | 12,311 | 1,758,271 | 1,685,829 | 6,750,232 | $512,348 00 |

## *Returns from Lobster Fisheries, 1919.*

["S" indicates that the proprietor was also engaged in shore fisheries to a greater extent than lobster fishery. Information will be found in the table entitled "Returns from the Shore Net and Pound Fisheries for the Year 1919."]

| Proprietor. | Town. | Number of Men. | Number of Boats. | Value. | Number of Pots. | Value. | Number of Lobsters. | Value. | Number of Egg Lobsters. |
|---|---|---|---|---|---|---|---|---|---|
| Chas. H. Hinckley, | Barnstable, | 1 | 1 | | | | | | |
| Shirley D. Lovell, | Barnstable, | S | S | $35 00 | 153 | $234 00 | 2,188 | $1,309 95 | 45 |
| Nelson Marchant, | Barnstable, | S | S | | | | | | |
| Lazarus Cathcart, | Barnstable, | 1 | - | | | | | | |
| Emile Bouchard, | Beverly, | 1 | 1 | | | | | | |
| David Bouchard, | Beverly, | 1 | 1 | | | | | | |
| William Bouchard, | Beverly, | 1 | 1 | | | | | | |
| Luther A. Cahoon, | Beverly, | 1 | 1 | | | | | | |
| Charles A. Davis, | Beverly, | 1 | 1 | | | | | | |
| Harry C. Hannable, | Beverly, | 1 | 1 | 1,423 00 | 512 | 1,179 00 | 26,888 | 9,083 17 | 266 |
| Oliver C. Hersey, | Beverly, | 1 | 1 | | | | | | |
| Warland Hersey, | Beverly, | 1 | 2 | | | | | | |
| Joseph Julius, | Beverly, | 1 | 1 | | | | | | |
| Ernest Osheng, | Beverly, | 1 | 2 | | | | | | |
| Nelson O. Southwick, | Beverly, | 1 | 2 | | | | | | |
| W. R. Weeks, | Beverly, | 1 | 1 | | | | | | |
| Hjalmar Roos, | Boston, | 1 | 3 | 740 00 | 202 | 605 00 | 3,248 | 1,943 36 | 186 |
| Edward L. Spencer, | Boston, | 1 | 1 | | | | | | |
| Arthur H. Gibbs, | Bourne, | 1 | 3 | | | | | | |
| Paul D. Gibbs, | Bourne, | 3 | 3 | | | | | | |
| Charles Benson, | Bourne, | 1 | 1 | 2,065 00 | 472 | 1,275 00 | 12,750 | 4,346 56 | 186 |
| Joseph M. Butts, | Bourne, | 1 | - | | | | | | |
| Paul D. Gibbs and Louis Swift, | Bourne, | 1 | 2 | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| George W. Bloomer and George W. Bloomer, Jr., | Chatham, | S | S | | | | | | |
| George C. Dunbar, | Chatham, | – | – | | | | | | |
| Eugene Eldredge, | Chatham, | 1 | 3 | | | | | | |
| Howard Eldredge, | Chatham, | 1 | 2 | | | | | | |
| Charles G. Hamilton, | Chatham, | 1 | 2 | | | | | | |
| T. W. Holway, | Chatham, | S | S | 2,810 00 | 705 | 990 00 | 11,158 | 5,235 04 | 330 |
| Ralph Hunter, | Chatham, | 2 | 2 | | | | | | |
| F. G. James, | Chatham, | 1 | 2 | | | | | | |
| M. Meade, | Chatham, | 1 | 2 | | | | | | |
| Seymour Patterson, | Chatham, | S | S | | | | | | |
| John S. Pitts, | Chatham, | 1 | 2 | | | | | | |
| David T. Butler, | Chilmark, | 1 | 3 | | | | | | |
| Roy E. Cottle, | Chilmark, | 1 | 3 | | | | | | |
| Ingval J. Dalen, | Chilmark, | 2 | 2 | | | | | | |
| Ernest J. Dean and Joseph Joseph, | Chilmark, | 2 | 2 | | | | | | |
| Robert M. Flanders, | Chilmark, | – | 1 | | | | | | |
| Jerry Look, | Chilmark, | 1 | 2 | | | | | | |
| James A. Mayhew, | Chilmark, | 1 | 2 | | | | | | |
| Ernest C. Mayhew, | Chilmark, | 1 | 1 | | | | | | |
| Lester D. Mayhew, | Chilmark, | 1 | 1 | | | | | | |
| Benjamin C. Mayhew, | Chilmark, | 1 | 1 | | | | | | |
| Wm. S. Mayhew, | Chilmark, | 1 | 1 | 9,380 00 | 1,470 | 3,649 00 | 120,541 | 28,212 25 | 1,369 |
| Clarence Morgan, | Chilmark, | 2 | 1 | | | | | | |
| Everett A. Poole, | Chilmark, | 1 | 3 | | | | | | |
| Albert E. Reed, | Chilmark, | 1 | 3 | | | | | | |
| Carl E. Reed, | Chilmark, | 1 | 1 | | | | | | |
| Harry G. Reed, | Chilmark, | 1 | 1 | | | | | | |
| Onslow Stuart, | Chilmark, | 1 | 1 | | | | | | |
| Joseph Tilton, | Chilmark, | 1 | 1 | | | | | | |
| Ralph F. Tilton, | Chilmark, | 1 | 1 | | | | | | |
| Welcome L. Tilton, | Chilmark, | 1 | 1 | | | | | | |
| William S. Tilton, | Chilmark, | 1 | 1 | | | | | | |
| George T. Ainslee, | Cohasset, | 1 | 1 | | | | | | |
| John Eltman, | Cohasset, | 1 | 2 | | | | | | |
| Antoine S. Figueiredo, | Cohasset, | 4 | 2 | | | | | | |
| Antone Grassie, | Cohasset, | 1 | 1 | | | | | | |
| Harry B. Kimball, | Cohasset, | – | 2 | | | | | | |
| Alton J. Priest, | Cohasset, | 1 | 1 | | | | | | |
| Alonzo Pearson, | Cohasset, | 1 | – | 4,593 00 | 1,459 | 3,814 00 | 5,974 | 9,303 54 | 353 |
| Orne Peterson, | Cohasset, | 1 | 1 | | | | | | |
| Manuel E. Salvatore, | Cohasset, | 1 | 11 | | | | | | |
| Carl Weissman, | Cohasset, | 1 | 2 | | | | | | |
| Joseph A. Silvia, | Cohasset, | 1 | 3 | | | | | | |
| Joseph M. Silvia, | Cohasset, | 1 | 1 | | | | | | |

*Returns from Lobster Fisheries, 1919* — Continued.

| PROPRIETOR. | Town. | Number of Men. | Number of Boats. | Value. | Number of Pots. | Value. | Number of Lobsters. | Value. | Number of Egg Lobsters. |
|---|---|---|---|---|---|---|---|---|---|
| Oscar F. Gibbs, | Dennis, | 1 | 2 | | | | | | |
| George E. Hall, | Dennis, | S | S | | | | | | |
| Wilfred A. Hall, | Dennis, | 1 | 3 | $290 00 | 265 | $255 00 | 6,048 | $2,196 25 | 115 |
| Isaac W. Tuck, | Dennis, | 1 | 2 | | | | | | |
| Benjamin Walker, | Dennis, | S | S | | | | | | |
| Samuel G. I. Wadsworth, | Duxbury, | 1 | 3 | 80 00 | 45 | - | 827 | 372 15 | 45 |
| Domingo Brown, | Fairhaven, | - | - | | | | | | |
| Charles W. Cook, | Fairhaven, | S | S | | | | | | |
| Frank Corey, | Fairhaven, | 1 | 1 | | | | | | |
| Manuel F. Costa, | Fairhaven, | 1 | 2 | 905 00 | 321 | 286 25 | 20,637 | 4,198 00 | 195 |
| Peter Fontaine, | Fairhaven, | 1 | 2 | | | | | | |
| Miguel Gonsalves, | Fairhaven, | 1 | 2 | | | | | | |
| James F. Cook, | Falmouth, | 1 | 2 | | | | | | |
| Fred J. Erskine, | Falmouth, | 1 | 1 | | | | | | |
| C. W. Fisher, | Falmouth, | 1 | 1 | | | | | | |
| Charles R. Grinnell, | Falmouth, | 1 | 1 | | | | | | |
| Reuben Hamblin, | Falmouth, | 1 | - | | | | | | |
| Alfred M. Hilton, | Falmouth, | 1 | 2 | | | | | | |
| Oscar R. Hilton, | Falmouth, | 1 | 1 | | | | | | |
| Alfred Hilton, | Falmouth, | 1 | 1 | | | | | | |
| Francis Minot, | Falmouth, | 2 | 2 | | | | | | |
| Walter E. Nickerson, | Falmouth, | 1 | 1 | 5,035 50 | 469 | 1,133 50 | 22,434 | 5,562 13 | 232 |
| B. K. Nickerson, | Falmouth, | 1 | 1 | | | | | | |
| Alfred Nickerson, | Falmouth, | 1 | 1 | | | | | | |
| Harry A. Phinney, | Falmouth, | 1 | 1 | | | | | | |
| Horatio D. Smith, | Falmouth, | 1 | 1 | | | | | | |
| Prince M. Stuart, | Falmouth, | 1 | 2 | | | | | | |
| A. C. Swain, Jr., | Falmouth, | 1 | 2 | | | | | | |
| John J. Veeder, | Falmouth, | 1 | 1 | | | | | | |
| Robert M. Veeder, | Falmouth, | 1 | 1 | | | | | | |
| Arthur S. Weeks, | Falmouth, | 1 | 1 | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Moses P. Cooper, | Gay Head, | 1 | 2 | 2,347 00 | 464 | 1,204 00 | 33,261 | 7,947 30 | 428 |
| Nathan A. Francis, | Gay Head, | 1 | 3 | | | | | | |
| Marshall Jeffers, | Gay Head, | 2 | 2 | | | | | | |
| Joseph H. Lang, | Gay Head, | 1 | 1 | | | | | | |
| Francis Manning, | Gay Head, | 1 | 1 | | | | | | |
| Walter W. Manning, | Gay Head, | 1 | 1 | | | | | | |
| Augustus Reinertson, | Gay Head, | 1 | 2 | | | | | | |
| Charles H. Ryan, | Gay Head, | 1 | 4 | | | | | | |
| Leander B. Smalley, | Gay Head, | 1 | 2 | | | | | | |
| Edward L. Ashley, | Gloucester, | 1 | 2 | 4,672 00 | 2,444 | 4,622 00 | 65,581 | 22,975 72 | 420 |
| Henry Ashley, | Gloucester, | 1 | 2 | | | | | | |
| Frank Balcombe, | Gloucester, | 2 | 2 | | | | | | |
| Frank B. Brewer, | Gloucester, | 1 | 1 | | | | | | |
| Daniel S. Burnham, | Gloucester, | 1 | 1 | | | | | | |
| Frank F. Butler, | Gloucester, | 1 | 1 | | | | | | |
| Clarence Davis, | Gloucester, | 1 | 2 | | | | | | |
| Wm. F. Enos, | Gloucester, | 1 | 1 | | | | | | |
| Wm. F. Enos, Jr., | Gloucester, | 1 | 1 | | | | | | |
| Antone Fenant, | Gloucester, | 1 | 1 | | | | | | |
| Joseph A. Goodwin, | Gloucester, | 1 | 1 | | | | | | |
| John B. Knowlton, | Gloucester, | – | – | | | | | | |
| Peter Knutson, | Gloucester, | 1 | 1 | | | | | | |
| Herman L. Marchant, | Gloucester, | 1 | 1 | | | | | | |
| Walter E. Marchant, | Gloucester, | 1 | 1 | | | | | | |
| Benjamin B. Marchant, | Gloucester, | 1 | 1 | | | | | | |
| David E. Mellman, | Gloucester, | 1 | 1 | | | | | | |
| Joseph Monez, | Gloucester, | 1 | 3 | | | | | | |
| Emil M. Nelson, | Gloucester, | 1 | 1 | | | | | | |
| Henry W. Nelson, | Gloucester, | S | S | | | | | | |
| William Parks, | Gloucester, | 1 | 2 | | | | | | |
| Fred Parsons, | Gloucester, | 1 | 1 | | | | | | |
| Fred Swanson, | Gloucester, | 1 | 1 | | | | | | |
| Manuel Viator, | Gloucester, | 1 | 2 | | | | | | |
| Manuel Viator, Jr., | Gloucester, | 1 | 2 | | | | | | |
| Daniel Webber, | Gloucester, | 1 | 1 | | | | | | |
| Walter White, | Gloucester, | 1 | 1 | | | | | | |
| George Wilkinson, | Gloucester, | 1 | 2 | | | | | | |
| Charles Wilson, | Gloucester, | 1 | 1 | | | | | | |
| Guy R. Wolfe, | Gloucester, | 1 | 2 | | | | | | |
| Eugene Oliver, | Gloucester, | 1 | 3 | | | | | | |
| Eugene Oliver, | Gloucester, | 1 | 2 | | | | | | |
| Albert Parsons, | Gloucester, | 1 | 1 | | | | | | |
| Ira Parsons, | Gloucester, | 1 | 1 | | | | | | |
| Philip Parsons, | Gloucester, | 1 | 1 | | | | | | |
| James E. Robinson, | Gloucester, | 1 | 2 | | | | | | |
| B. Franklin Saunders, | Gloucester, | 1 | – | | | | | | |
| Arthur Stevens, | Gloucester, | 1 | – | | | | | | |
| Eugene Barusso, | Gloucester, | 1 | 2 | | | | | | |

*Returns from Lobster Fisheries, 1919* — Continued.

| Proprietor. | Town. | Number of Men. | Number of Boats. | Value. | Number of Pots. | Value. | Number of Lobsters. | Value. | Number of Egg Lobsters. |
|---|---|---|---|---|---|---|---|---|---|
| David P. Bosworth, | Gosnold, | 1 | 2 | | | | | | |
| Wm. V. P. Bosworth, | Gosnold, | 1 | 1 | | | | | | |
| John Connell, | Gosnold, | 1 | 2 | | | | | | |
| Howard Connell and C. W. Allen, | Gosnold, | 2 | 2 | | | | | | |
| Harold F. Deane, | Gosnold, | 1 | 3 | | | | | | |
| Thomas B. Dowling, | Gosnold, | 2 | 1 | | | | | | |
| Bento Gonsalves, | Gosnold, | 2 | 2 | | | | | | |
| George C. King, | Gosnold, | 1 | 6 | $11,791 00 | 1,835 | $5,182 00 | 124,627 | $28,044 06 | 825 |
| John A. McKay, | Gosnold, | 2 | 2 | | | | | | |
| Louis J. Ramos, | Gosnold, | 1 | 2 | | | | | | |
| Russell W. Rotch, | Gosnold, | 1 | 2 | | | | | | |
| George B. Taber, | Gosnold, | 1 | 1 | | | | | | |
| Isaac C. Tilton and Robt. R. Tilton, | Gosnold, | 2 | 1 | | | | | | |
| A. P. Tilton, | Gosnold, | 1 | 1 | | | | | | |
| Carleton L. Veeder, | Gosnold, | 1 | 2 | | | | | | |
| Lincoln C. Bartlett, | Kingston, | 2 | 2 | | | | | | |
| Charles A. Maybry, | Kingston, | 2 | 2 | 1,300 00 | 149 | 440 00 | 2,294 | 819 00 | 13 |
| H. S. West, | Kingston, | 1 | 2 | | | | | | |
| Alfred W. Riley, | Lanesville, | 1 | – | – | 40 | 40 00 | 650 | 208 75 | 4 |
| Henry O. Bohaker, | Manchester, | 1 | 1 | 55 00 | 49 | 135 50 | 1,587 | 745 51 | 10 |
| Otis F. Bohaker, | Manchester, | 1 | 1 | | | | | | |
| H. A. Slade, | Manomet, | 1 | 1 | 30 00 | 9 | 24 50 | 713 | 77 75 | 6 |
| Fred Wood, | Manomet, | 1 | 1 | | | | | | |
| William F. Allen, | Marblehead, | 1 | 1 | | | | | | |
| Ernest Cronk, | Marblehead, | 1 | 2 | | | | | | |
| Charles O. Briggs, | Marblehead, | 1 | 1 | | | | | | |
| Charles H. Foss and Caleb H. Foss, | Marblehead, | 2 | – | | | | | | |
| Arthur D. Frost, | Marblehead, | 1 | 2 | | | | | | |
| G. Stanley Frost, | Marblehead, | 1 | 1 | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| J. Frank Gilbert, | Marblehead, | 1 | 2 | | | | | | |
| John F. Gilbert, | Marblehead, | 1 | 1 | | | | | | |
| J. G. Gilbert, | Marblehead, | 1 | 2 | | | | | | |
| John G. Howe, | Marblehead, | 1 | 1 | | | | | | |
| George C. Luscomb, | Marblehead, | 1 | 1 | | | | | | |
| Louis Letourneau, | Marblehead, | 1 | 2 | | | | | | |
| John W. Mace, | Marblehead, | 1 | 1 | | | | | | |
| James G. Magee, | Marblehead, | 1 | 1 | 7,031 00 | 1,529 | 3,270 00 | 83,246 | 27,534 31 | 1,084 |
| Harry A. Oliver, | Marblehead, | 1 | 1 | | | | | | |
| Augustus K. Roundy, | Marblehead, | 1 | 2 | | | | | | |
| Richard Russell, | Marblehead, | 1 | 1 | | | | | | |
| Wm. T. Smith, | Marblehead, | 1 | 1 | | | | | | |
| Stephen Q. Smith, | Marblehead, | 1 | 1 | | | | | | |
| Ebenezer Snow, | Marblehead, | 1 | 2 | | | | | | |
| John S. Stacey, | Marblehead, | 1 | 1 | | | | | | |
| John R. Stacey, | Marblehead, | 1 | - | | | | | | |
| Wm. B. Standley, | Marblehead, | 1 | 2 | | | | | | |
| Charles H. Smith, | Marblehead, | 1 | 1 | | | | | | |
| Wm. H. Sweet, | Marblehead, | 1 | 2 | | | | | | |
| Samuel A. Stone, | Marblehead, | 1 | 1 | | | | | | |
| Wm. H. Tutt, | Marblehead, | 1 | 2 | | | | | | |
| J. S. Withum, | Marblehead, | 1 | 2 | | | | | | |
| O. B. Blackman, | Marshfield, | 1 | 1 | | | | | | |
| I. H. Bourne, | Marshfield, | 1 | 1 | | | | | | |
| W. M. Englestead, | Marshfield, | 1 | 3 | | | | | | |
| M. F. Ewell, | Marshfield, | 1 | 2 | | | | | | |
| Fred L. Ford, | Marshfield, | 1 | 1 | | | | | | |
| George Graham, | Marshfield, | 1 | 2 | | | | | | |
| Whitfield Hamilton, | Marshfield, | 1 | 3 | | | | | | |
| Wilfred Keene, | Marshfield, | 1 | 3 | 5,015 00 | 1,242 | 3,045 00 | 41,913 | 11,547 17 | 380 |
| Charles R. Peterson, | Marshfield, | 1 | 2 | | | | | | |
| C. E. Peterson, | Marshfield, | 1 | 2 | | | | | | |
| E. Pierce, | Marshfield, | 1 | 2 | | | | | | |
| Ellet S. Publicover, | Marshfield, | 1 | 2 | | | | | | |
| Lyman Sears, | Marshfield, | 1 | 3 | | | | | | |
| S. H. Staples, | Marshfield, | 1 | 1 | | | | | | |
| J. E. White, | Marshfield, | 3 | 6 | | | | | | |
| A. Felicetti, | Nahant, | 1 | 1 | 685 00 | 115 | 180 00 | 3,780 | 770 68 | 3 |
| W. A. Smith, | Nahant, | 1 | 2 | | | | | | |
| Walter Jewett, | Nantucket, | 1 | 2 | 890 00 | 156 | 280 00 | 2,408 | 743 00 | 9 |
| Joseph Mayo, | Nantucket, | 2 | 2 | | | | | | |

*Returns from Lobster Fisheries, 1919* — Continued.

| Proprietor. | Town. | Number of Men. | Number of Boats. | Value. | Number of Pots. | Value. | Number of Lobsters. | Value. | Number of Egg Lobsters. |
|---|---|---|---|---|---|---|---|---|---|
| Anast Angelo, | New Bedford, | 1 | 1 | | | | | | |
| John Barao, | New Bedford, | 1 | 1 | | | | | | |
| Manuel Brown, | New Bedford, | 1 | 1 | | | | | | |
| Strat Buzzer, | New Bedford, | 1 | 1 | | | | | | |
| John Coraludes and Constantino Coraludes, | New Bedford, | 1 | 2 | | | | | | |
| Joseph S. Sutra, | New Bedford, | 1 | 2 | | | | | | |
| George A. Falkner, | New Bedford, | 1 | 1 | | | | | | |
| Victorino Furtado, | New Bedford, | 2 | 3 | | | | | | |
| Joseph Ferreira, | New Bedford, | 1 | 1 | | | | | | |
| Joseph Mello Gonsalves, | New Bedford, | 2 | 2 | | | | | | |
| Anastos Koniz, | New Bedford, | 1 | 2 | | | | | | |
| John Kafaczewski, | New Bedford, | 1 | 1 | | | | | | |
| Joseph Lima, | New Bedford, | 1 | 2 | | | | | | |
| Joseph Madero, | New Bedford, | 1 | 1 | | | | | | |
| Nick Martin, | New Bedford, | 1 | 1 | $8,451 00 | 4,104 | $8,885 00 | 136,817 | $34,280 10 | 2,081 |
| Angelos Mavriginos, | New Bedford, | 1 | 1 | | | | | | |
| Charles H. Mattson, | New Bedford, | 1 | 1 | | | | | | |
| John Moniz, | New Bedford, | 1 | 2 | | | | | | |
| Antone Borges Mello, | New Bedford, | 1 | 2 | | | | | | |
| John Pestona, | New Bedford, | 1 | 1 | | | | | | |
| Manuel Roderick, | New Bedford, | 1 | 1 | | | | | | |
| August Robiero, | New Bedford, | 1 | 1 | | | | | | |
| Jacito Rosa, | New Bedford, | 1 | 2 | | | | | | |
| Manuel F. Rose and Manuel F. Rose, Jr., | New Bedford, | 2 | 3 | | | | | | |
| Manuel Severins, | New Bedford, | 1 | 3 | | | | | | |
| August Souza, | New Bedford, | 1 | 1 | | | | | | |
| Joseph C. Souza, | New Bedford, | 1 | 2 | | | | | | |
| Antone Souza, | New Bedford, | 2 | 1 | | | | | | |
| Antonio Veira, | New Bedford, | 1 | 2 | | | | | | |
| Anastanio Vulgares, | New Bedford, | 1 | 1 | | | | | | |
| Nicholas Volmas, | New Bedford, | 1 | 2 | | | | | | |
| Daniel B. Gould, | Orleans, | 2 | 3 | 310 00 | 50 | 150 00 | 700 | 425 00 | 18 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Eugene H. Arnold, | Plymouth, | 1 | 1 | | | | | | |
| Edwin H. Bartlett, | Plymouth, | 1 | 2 | | | | | | |
| John A. Brierly, | Plymouth, | 1 | 1 | | | | | | |
| Laban B. Briggs, | Plymouth, | 1 | 2 | | | | | | |
| L. B. Briggs, | Plymouth, | 1 | 1 | | | | | | |
| David H. Briggs, | Plymouth, | 1 | 1 | | | | | | |
| Frank P. Brooks, | Plymouth, | 1 | 1 | | | | | | |
| Samuel H. Benson, | Plymouth, | 1 | 1 | | | | | | |
| Samuel B. Blackmer, | Plymouth, | 1 | 2 | | | | | | |
| Albert W. Boutin, | Plymouth, | 1 | 2 | | | | | | |
| Harry J. Boutin, | Plymouth, | 1 | 2 | | | | | | |
| Joseph Casson, | Plymouth, | 1 | 1 | | | | | | |
| H. J. Caswell, | Plymouth, | 1 | 2 | | | | | | |
| H. D. Cleveland, | Plymouth, | 1 | 2 | | | | | | |
| C. H. Dixon, | Plymouth, | 1 | 1 | | | | | | |
| Charles A. Dixon, | Plymouth, | 1 | 1 | | | | | | |
| Wm. T. Darrick, | Plymouth, | 1 | 2 | | | | | | |
| Edward L. Dixon, | Plymouth, | 1 | 2 | | | | | | |
| Charles H. Davis, | Plymouth, | 1 | 2 | | | | | | |
| Herbert B. Eddy, | Plymouth, | 1 | 1 | | | | | | |
| George R. Ellis, | Plymouth, | 1 | 2 | | | | | | |
| Arthur Garuta, | Plymouth, | 1 | 2 | | | | | | |
| Patrick H. Glynn, | Plymouth, | 1 | 1 | | | | | | |
| Harold A. Hadaway, | Plymouth, | 1 | 1 | | | | | | |
| J. R. Harlow, | Plymouth, | 1 | 2 | | | | | | |
| E. C. Hayward, | Plymouth, | 1 | 1 | | | | | | |
| Ralph B. Holmes, | Plymouth, | 1 | 2 | | | | | | |
| Wm. H. Husband, | Plymouth, | 1 | 2 | | | | | | |
| Roger C. Holden, | Plymouth, | 1 | 1 | | | | | | |
| Ernest Johns, | Plymouth, | 1 | 2 | | | | | | |
| G. W. Keith, | Plymouth, | 1 | 1 | | | | | | |
| Thomas C. Longstreth, | Plymouth, | 1 | 1 | | | | | | |
| Percy H. Marsh, | Plymouth, | 1 | 2 | 13,489 00 | 2,971 | 6,963 50 | 118,371 | 35,715 79 | 640 |
| Albert E. Nightingale, | Plymouth, | 1 | 2 | | | | | | |
| W. J. Nightingale, | Plymouth, | 1 | 2 | | | | | | |
| Alvin E. Nightingale, | Plymouth, | 1 | 1 | | | | | | |
| F. R. Peterson, | Plymouth, | 1 | 1 | | | | | | |
| Charles H. Pierce, | Plymouth, | 1 | 2 | | | | | | |
| Albert F. Pierce, | Plymouth, | 1 | 4 | | | | | | |
| Wm. H. Pridham, | Plymouth, | 1 | 1 | | | | | | |
| Nathan W. Pratt, | Plymouth, | 1 | 1 | | | | | | |
| Henry L. Perry, | Plymouth, | 1 | 1 | | | | | | |
| Henry Quinehon, | Plymouth, | 1 | 2 | | | | | | |
| Charles W. Raymond, | Plymouth, | 1 | 1 | | | | | | |
| Augustus B. Rogers. | Plymouth, | 1 | 1 | | | | | | |

*Returns from Lobster Fisheries, 1919* — Continued.

| Proprietor. | Town. | Number of Men. | Number of Boats. | Value. | Number of Pots. | Value. | Number of Lobsters. | Value. | Number of Egg Lobsters. |
|---|---|---|---|---|---|---|---|---|---|
| J. Albert Russell, | Plymouth, | 1 | 3 | | | | | | |
| Robert Richardson, | Plymouth, | 1 | 1 | | | | | | |
| W. L. Russell, Jr., | Plymouth, | 1 | 1 | | | | | | |
| H. A. Ryder, | Plymouth, | 1 | 2 | | | | | | |
| Harry L. Sampson, | Plymouth, | 1 | 2 | | | | | | |
| George M. Sampson, | Plymouth, | 1 | 1 | | | | | | |
| C. M. Sampson, | Plymouth, | 1 | 1 | | | | | | |
| R. L. Sherman, | Plymouth, | 1 | 1 | | | | | | |
| Levi Thurston, | Plymouth, | 1 | 2 | | | | | | |
| R. Sherbourne, | Plymouth, | 1 | 1 | | | | | | |
| Frank Simmons, | Plymouth, | 1 | 1 | | | | | | |
| Enrico Trentini, | Plymouth, | 1 | 1 | | | | | | |
| Daniel G. Town, | Plymouth, | 1 | 2 | | | | | | |
| James S. A. Waller, | Plymouth, | 1 | 1 | | | | | | |
| John M. Watson, | Plymouth, | 1 | 1 | | | | | | |
| Pelham H. Whiting, | Plymouth, | 1 | 1 | | | | | | |
| Albert D. White, | Plymouth, | 1 | 2 | | | | | | |
| Dennis P. Ward, | Plymouth, | 1 | 2 | | | | | | |
| George W. Wood, | Plymouth, | 1 | 1 | | | | | | |
| William F. Farley, | Plymouth, | 1 | 1 | | | | | | |
| John S. Nickerson, | Provincetown, | 1 | 1 | $30 00 | 54 | $34 00 | 129 | $48 04 | 23 |
| John M. Savage, | Provincetown, | 1 | 1 | | | | | | |
| John Roscoe Allen, | Rockport, | 1 | 2 | | | | | | |
| Howard S. Bates, | Rockport, | 1 | 1 | | | | | | |
| William E. Bennett, | Rockport, | 1 | 1 | | | | | | |
| John B. Bowman, | Rockport, | 1 | 1 | | | | | | |
| Martin Bowman, | Rockport, | 1 | 1 | | | | | | |
| John M. Enos, | Rockport, | 1 | 1 | | | | | | |
| Frank S. Hill, | Rockport, | 1 | 1 | | | | | | |
| Fred Hobbs, | Rockport, | 1 | 2 | | | | | | |
| John F. Lawson, | Rockport, | 1 | 1 | | | | | | |
| Carl E. Nelson, | Rockport, | 1 | 1 | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Herman Nelson, | Rockport, | 1 | 1 | 4,294 35 | 1,685 | 4,412 50 | 71,665 | 25,648 78 | 437 |
| John Alfred Nelson, | Rockport, | 1 | 3 | | | | | | |
| Carl F. Norberg, | Rockport, | 1 | 1 | | | | | | |
| Arthur Norwood, | Rockport, | 1 | 2 | | | | | | |
| Arthur Rich, Esq., | Rockport, | 1 | 1 | | | | | | |
| Herbert R. Rich, | Rockport, | 1 | 2 | | | | | | |
| Everett D. Rowe, | Rockport, | 1 | 1 | | | | | | |
| John J. Stillman, | Rockport, | 1 | 1 | | | | | | |
| Andrew Swanson, | Rockport, | 1 | 1 | | | | | | |
| Samuel Thurston, | Rockport, | 1 | 2 | | | | | | |
| Charles C. Upham, | Rockport, | 1 | 3 | | | | | | |
| George E. Wendell, | Rockport, | 1 | 2 | | | | | | |
| Charles S. Brown, | Salem, | 1 | 1 | | | | | | |
| George W. Dunn, | Salem, | 2 | 2 | | | | | | |
| Daniel C. Fitz, | Salem, | 1 | 1 | | | | | | |
| W. H. Foye, | Salem, | 1 | 1 | 1,817 00 | 417 | 971 50 | 23,850 | 9,760 96 | 122 |
| John A. Dunn, | Salem, | 2 | 2 | | | | | | |
| Anthoney J. Gonet, | Salem, | S | S | | | | | | |
| Thomas F. Hogan, | Salem, | 1 | 1 | | | | | | |
| George W. Berry, | Salem, | 1 | 2 | | | | | | |
| George Russell Littlefield, | Salisbury, | 1 | 1 | 200 00 | 55 | 90 00 | 1,977 | 578 65 | 5 |
| E. W. Haines, | Sandwich, | S | S | | | | | | |
| Arthur S. Hamblin, | Sandwich, | 1 | 1 | | | | | | |
| A. J. McArdle, | Sandwich, | 1 | 2 | 415 00 | 188 | 355 00 | 6,782 | 2,724 18 | 576 |
| Patrick McKeon, | Sandwich, | 1 | 1 | | | | | | |
| Robert P. Nockel, | Sandwich, | 1 | 2 | | | | | | |
| Oscar Anderson, Esq., | Scituate, | 1 | 1 | | | | | | |
| A. L. Baker, | Scituate, | 1 | 1 | | | | | | |
| Frank H. Bang, | Scituate, | 1 | 1 | | | | | | |
| Fred Bergman, | Scituate, | 1 | 1 | | | | | | |
| Fred A. Conroy, | Scituate, | 1 | 1 | | | | | | |
| Bentley Curran, | Scituate, | 1 | 1 | | | | | | |
| Chas. P. Curran, | Scituate, | 1 | 1 | | | | | | |
| Martin Curran, Jr., | Scituate, | 1 | 1 | | | | | | |
| John F. Cushman, | Scituate, | 1 | 1 | | | | | | |
| C. Hersey Driscoll, | Scituate, | 1 | 1 | | | | | | |
| John F. Driscoll, | Scituate, | 1 | 1 | | | | | | |
| Wm. Driscoll, | Scituate, | 1 | 1 | | | | | | |
| George F. Dwyer, | Scituate, | 1 | 1 | | | | | | |
| Joseph Flynn, | Scituate, | 1 | 1 | | | | | | |

*Returns from Lobster Fisheries, 1919* — Concluded.

| Proprietor. | Town. | Number of Men. | Number of Boats. | Value. | Number of Pots. | Value. | Number of Lobsters. | Value. | Number of Egg Lobsters. |
|---|---|---|---|---|---|---|---|---|---|
| John Flynn, | Scituate, | 1 | 1 | | | | | | |
| Wm. J. Flynn, | Scituate, | 1 | 1 | | | | | | |
| David F. Fraser, | Scituate, | 1 | 1 | | | | | | |
| Richard Graham, | Scituate, | 1 | 1 | | | | | | |
| R. Frank Hall, | Scituate, | 1 | 1 | | | | | | |
| Thomas H. Harris, | Scituate, | 1 | 1 | | | | | | |
| Moses H. Jellows, | Scituate, | 1 | 1 | $6,415 00 | 2,596 | $7,326 75 | 109,708 | $30,503 58 | 650 |
| Maxwell Jenkins, | Scituate, | 1 | 1 | | | | | | |
| Fred G. McCarthy, | Scituate, | 1 | 1 | | | | | | |
| James L. McCarthy, | Scituate, | 1 | 1 | | | | | | |
| Joseph Nee, | Scituate, | 1 | 1 | | | | | | |
| James J. O'Hern, | Scituate, | 1 | 1 | | | | | | |
| Christopher O'Neill, | Scituate, | 1 | 1 | | | | | | |
| Christopher O'Neill, Jr., | Scituate, | 1 | 1 | | | | | | |
| Eugene Pratt, | Scituate, | 1 | 2 | | | | | | |
| Dennis F. Quinn, | Scituate, | 1 | 1 | | | | | | |
| Martin J. Quinn, | Scituate, | 1 | 1 | | | | | | |
| Albert E. Reed, | Scituate, | 1 | 1 | | | | | | |
| William Stanley, | Scituate, | 1 | 1 | | | | | | |
| C. Bertram Tilden, | Scituate, | 1 | 1 | | | | | | |
| Henry P. Tobin, | Scituate, | 1 | 1 | | | | | | |
| Thomas S. Turner, | Scituate, | 1 | 2 | | | | | | |
| Edward Ward, | Scituate, | 1 | 1 | | | | | | |
| Edw. Ward, | Scituate, | 1 | 1 | | | | | | |
| James W. Welch, | Scituate, | 1 | 1 | | | | | | |
| Richard Wherity, | Scituate, | 1 | 1 | | | | | | |
| Frank H. Young, | Scituate, | 1 | 1 | | | | | | |
| George H. Bond, | Swampscott, | 1 | 2 | 245 00 | 40 | 90 00 | 982 | 349 00 | 9 |
| Norman C. Benson, | Tisbury, | S | S | | | | | | |
| E. W. Cleveland, | Tisbury, | 1 | 2 | | | | | | |
| J. R. Cleveland, | Tisbury, | 1 | 1 | 264 50 | 99 | 238 00 | 3,860 | 1,135 80 | 220 |
| F. M. Chace, | Tisbury, | 1 | 1 | | | | | | |
| H. Nelson Luce, | Tisbury, | 1 | 3 | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Lester A. Bowman, | Westport, | 1 | 2 | | | | | | |
| Arthur R. Cornell, | Westport, | 1 | 1 | | | | | | |
| Joseph S. Field, | Westport, | 1 | 2 | | | | | | |
| John R. Fish, | Westport, | 1 | 1 | | | | | | |
| J. R. Fish, Jr., and Herbert E. Fish, | Westport, | 1 | 3 | | | | | | |
| George L. Gilbert, | Westport, | 1 | 1 | | | | | | |
| Frank D. Grinnell, | Westport, | 1 | 1 | | | | | | |
| Herman A. Hart, | Westport, | 1 | 2 | 4,970 00 | 988 | 2,662 00 | 46,079 | 9,909 00 | 494 |
| Wm. S. Head, | Westport, | 1 | 1 | | | | | | |
| F. W. Jennings, | Westport, | 1 | 1 | | | | | | |
| Lester A. Mosher, | Westport, | 3 | 3 | | | | | | |
| A. S. Nickerson, | Westport, | 1 | 1 | | | | | | |
| Isaac B. Pettey, | Westport, | 1 | 1 | | | | | | |
| H. G. Sowle, | Westport, | 1 | 3 | | | | | | |
| Carlton N. Wood, | Westport, | 3 | 3 | | | | | | |
| Francis J. Cain, | Weymouth, | 2 | 1 | 150 00 | 125 | 200 00 | 8,304 | 4,931 51 | 37 |
| Elmer Newell, | Yarmouth, | 1 | 2 | | | | | | |
| Nemiah Newell, | Yarmouth, | 1 | 1 | 2,110 00 | 241 | 510 00 | 1,904 | 2,668 87 | 204 |
| Wm. H. Newell, | Yarmouth, | 2 | 2 | | | | | | |
| Totals, | | 436 | 614 | $104,333 35 | 27,718 | $64,732 00 | 1,123,881 | $331,854 91 | 12,020 |